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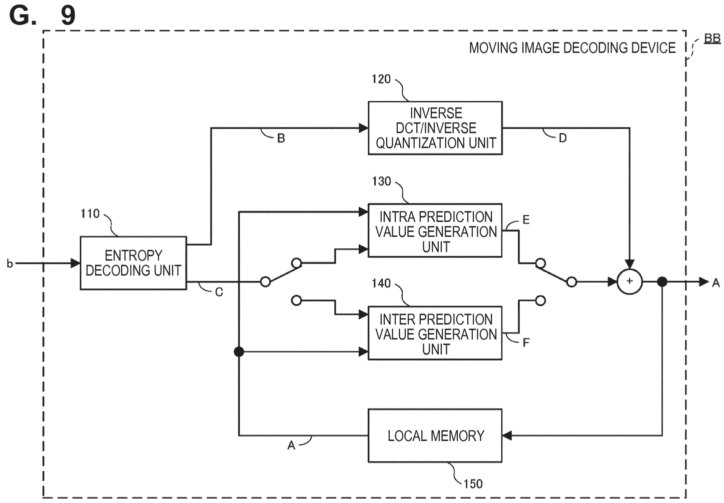
(54) **MOVING IMAGE CODING DEVICE, MOVING IMAGE DECODING DEVICE, MOVING IMAGE CODING METHOD, MOVING IMAGE DECODING METHOD, AND PROGRAM**

(57) Compression performance is improved in intra prediction. A moving image decoding device BB estimates a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter of the statistic of the prediction error. Regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of the prediction value at a pixel near a pixel to be processed is calculated. Furthermore, a prediction error corresponding to a distance from a reference pixel to a pixel to be processed is estimated using the aforementioned parameter of the statistic, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated.

FIG. 9



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Description

TECHNICAL FIELD

[0001] The present invention relates to moving image coding devices, moving image decoding devices, moving image coding methods, moving image decoding methods, and programs.

BACKGROUND ART

[0002] In the standard methods related to video compression represented by Non-patent reference 1 and Non-patent reference 2, in in-screen prediction (intra prediction), a method is used in which a reference value, which is a decoded value of an adjacent coded block, is used as a prediction value for a pixel located at a position along a prediction direction. With this method, a plurality of prediction directions are defined in advance, and coding performance can be improved by applying an appropriate prediction direction.

[0003] Non-patent reference 3 and Non-patent reference 4 describe a method in which, in the aforementioned intra prediction, the reference value is weighted based on a pixel value of a neighboring decoded pixel, rather than using a simple copy of the reference value. Non-patent reference 5 describes a method of weighting a reference pixel based on a result of analysis that corresponds to the distance from the reference pixel.

PRIOR ART DOCUMENT(S)

NON-PATENT REFERENCE

[0004]

Non-patent reference 1: "High Efficiency Video Coding (HEVC) text specification draft10," JCT-VC 12th meeting, JCTVC-L1003 v34, Jan. 2013.
Non-patent reference 2: Joint Video Team (JVT) of ISO/IEC MPEG and ITU-T VCEG, "Text of ISO/IEC 14496-10 Advanced Video Coding,"
Non-patent reference 3: L. Wang, L.-M. Po, Y. Uddin, K.-M. Wong and S. Li, "A Novel Weighted Cross Prediction for H.264 Intra Coding," ICME2009.
Non-patent reference 4: S. Yu, Y. Gao, J. Chen and J. Zhou, "Distance-based Weighted prediction for H,264 Intra Coding," ICALIP2008.
Non-patent reference 5 : R. Cha, O. C. Au, X. Fan, X. Zhang and J. Li, "Improved Combined Intra- Inter Prediction using Spatial-Variant Weighted Coefficient," ICME2011.

DISCLOSURE OF INVENTION

PROBLEMS THAT THE INVENTION IS TO SOLVE

[0005] With the methods described in Non-patent references 1 and 2, when generating the prediction value based on the prediction direction in the intra prediction, the correlation of the pixel values among pixels decreases as the distance between the pixels increases. For this reason, if the block size of a processing block increases, prediction performance decreases the further the distance of a pixel from the reference pixel is.

[0006] Then, a reduction in the block size of the processing block is conceivable. This can prevent an increase in the distance between pixels, and accordingly a decrease in the prediction performance can be suppressed. However, a reduction in the block size of the processing block increases the number of blocks, resulting in an increase in control information to be provided to each processing block, and there is a concern that compression performance cannot be improved.

[0007] With the methods described in Non-patent references 3 and 4, as for a pixel whose distance from a coded pixel is small in a processing block, improvement in compression performance can be expected. However, as the distance from a coded pixel increases in the processing block, improvement in the compression performance cannot be expected.

[0008] Meanwhile, with the method described in Non-patent reference 5, as mentioned above, a reference pixel is weighted based on a result of analysis that corresponds to the distance from the reference pixel. For this reason, improvement in compression performance can be expected even if the distance from the reference pixel is large. However, the method described in Non-patent reference 5 uses information of an inter coding frame when performing the aforementioned analysis. For this reason, improvement in compression performance cannot be expected in the intra prediction.

[0009] The present invention has been made in view of the foregoing problems, and an object of the invention is to improve compression performance in intra prediction.

MEANS OF SOLVING THE PROBLEMS

[0010] In order to solve the foregoing problems, the present invention proposes the following items.

(1) The present invention proposes a moving image coding device that permits generation of an intra prediction value that is based on an intra prediction direction, including: prediction error statistic evaluation means (corresponding, for example, to a prediction error statistic evaluation unit 30 in FIG. 2) for expressing, as a parameter, a statistic of a prediction error that is based on the intra prediction direction, and approximating the parameter (corresponding, for example, to an average and a variance, which will be described later) of the statistic in accordance with a distance from a reference pixel located along the intra prediction direction to a pixel to be processed; prediction value feature amount calculation

means (corresponding, for example, to a prediction value feature amount calculation unit 40 in FIG. 2) for calculating, for a pixel near the pixel to be processed, a feature amount of a prediction value that is based on the intra prediction direction; and prediction value calculation means (corresponding, for example, to a second prediction value calculation unit 50 in FIG. 2) for estimating a prediction error corresponding to the distance from the reference pixel located along the intra prediction direction to the pixel to be processed using the parameter of the statistic approximated by the prediction error statistic evaluation means, reflecting the prediction error in the prediction value (corresponding, for example, to an intra prediction value k in FIG. 2) that is based on the intra prediction direction using the feature amount calculated by the prediction value feature amount calculation means, and generating a new prediction value (corresponding, for example, to an intra prediction value d in FIG. 2).

According to this invention, the statistic of the prediction error that is based on the intra prediction direction is expressed as a parameter, and the statistic parameter is approximated in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed. Also, a feature amount of the prediction value that is based on the intra prediction direction is calculated for a pixel near the pixel to be processed. Furthermore, the prediction error corresponding to the aforementioned distance is estimated using the approximated statistic parameter, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated.

Therefore, it is possible to express, as a statistic, the occurrence frequency of a change in the pixel value for each distance from the reference pixel located along the intra prediction direction, and correct the prediction value that is based on the intra prediction direction using this statistic. Accordingly, the change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value that is based on the intra prediction direction.

Also, control information necessary for expressing a new generated prediction value is only a result of approximating the statistic parameter. For this reason, an increase in the control information to be provided to each processing block can be suppressed.

With the above-described configuration, in the intra prediction, a bit rate can be suppressed without decreasing video quality, and accordingly, compression performance can be improved.

(2) Regarding the moving image coding device in (1), the present invention proposes a moving image coding device in which the prediction error statistic evaluation means includes: statistic parameter calculation means (corresponding, for example, to a statistic parameter calculation unit 32 in FIG. 3) for evaluating the statistic of the prediction error that is based on the intra prediction direction, and parametrically expressing the statistic; parameter approximation means (corresponding, for example, to a parameter approximation unit 33 in FIG. 3) for approximating a parameter of the statistic obtained by the statistic parameter calculation means using an approximation function in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed; and parameter determination means (corresponding, for example, to a parameter determination unit 34 in FIG. 3) for estimating the statistic of the prediction error that is based on the intra prediction direction using the approximation function obtained by the parameter approximation means.

According to this invention, in the moving image coding device in (1), the prediction error statistic evaluation means is provided with the statistic parameter calculation means, the parameter approximation means, and the parameter determination means. The statistic of the prediction error that is based on the intra prediction direction is evaluated by the statistic parameter calculation means, and the statistic is parametrically expressed. The aforementioned statistic parameter is approximated using an approximation function in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed by the parameter approximation means. The statistic of the prediction error that is based on the intra prediction direction is estimated by the parameter determination means using the approximation function obtained by the parameter approximation means.

For this reason, the statistic parameter is approximated using the approximation function. Accordingly, the control information necessary for expressing a new generated prediction value is only a coefficient of the approximation function, and accordingly, the bit rate can be further suppressed.

(3) Regarding the moving image coding device in (2), the present invention proposes a moving image coding device in which the statistic parameter calculation means classifies a processing block into a plurality of divided blocks (corresponding, for example, to a first segment, a second segment, a third segment, and a fourth segment in FIG. 4) in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed, and evaluates the statistic in each of the plurality of divided blocks, and the parameter approximation means approximates the parameter of the statistic by means of linear approximation or polynomial approximation with a representative value (corresponding, for example, to a later-described segment number) of the distance from the reference pix-

el to the pixel to be processed in each of the plurality of divided blocks as a variable.

According to this invention, in the moving image coding device in (2), a processing block is classified into a plurality of divided blocks in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed, and the statistic in each of the plurality of divided blocks are evaluated by the statistic parameter calculation means. The statistic parameter is approximated by means of linear approximation or polynomial approximation with a representative value of the distance from the reference pixel to the pixel to be processed in each of the plurality of divided blocks as a variable by the parameter approximation means. Accordingly, the statistic parameter can be approximated in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed.

(4) Regarding any of the moving image coding devices in (1) to (3), the present invention proposes a moving image coding device in which the prediction error statistic evaluation means uses, as the statistic, a Laplace distribution expression with respect to a histogram of the prediction error.

According to this invention, in any of the moving image coding devices in (1) to (3), the Laplace distribution expression with respect to the histogram of the prediction error can be used as the statistic.

(5) Regarding the moving image coding device in (4), the present invention proposes a moving image coding device in which the prediction error statistic evaluation means uses, as the parameter of the statistic, an average and a variance of the Laplace distribution.

According to this invention, in the moving image coding device in (4), the average and the variance of a Laplace distribution can be used as parameters of the statistic.

(6) Regarding any of the moving image coding devices in (1) to (5), the present invention proposes a moving image coding device in which the prediction value calculation means estimates the prediction error using the parameter of the statistic, compares magnitudes of feature amounts calculated for pixels (corresponding, for example, to pixels in the first segment in FIG. 4) whose distance from the reference pixel is no smaller than a predetermined lower limit value and is smaller than a predetermined upper limit value by the prediction value feature amount calculation means among pixels in a processing block, and determines a pixel for reflecting the prediction error in a prediction value thereof from among the pixels in the processing block, based on a magnitude of the feature amount.

According to this invention, in any of the moving image coding devices in (1) to (5), the pixel for reflecting the prediction error in the prediction value thereof from among the pixels in the processing block is determined based on the magnitude of the feature amount. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel.

(7) Regarding the moving image coding device in (6), the present invention proposes a moving image coding device in which the prediction value calculation means has, in advance, a plurality of rules that define how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof, and selects one of the plurality of rules for each processing block, and determines the pixel for reflecting the prediction error in the prediction value thereof, in accordance with the selected rule.

According to this invention, in the moving image coding device in (6), one of the plurality of rules is selected for each processing block, and the pixel for reflecting the prediction error in the prediction value thereof is determined in accordance with the selected rule. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel by selecting a rule that corresponds to the image.

(8) Regarding the moving image coding device in (7), the present invention proposes a moving image coding device in which the prediction value calculation means has, as the plurality of rules, a rule for reflecting a large prediction error in a pixel having a large feature amount, and a rule for reflecting a large prediction error in a pixel having a small feature amount.

According to this invention, in the moving image coding device in (7), a rule for reflecting a large prediction error in a pixel having a large feature amount and a rule for reflecting a large prediction error in a pixel having a small feature amount are provided as the rules that define how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel by selecting these two rules as appropriate.

(9) Regarding any of the moving image coding devices in (1) to (8), the present invention proposes a moving image coding device in which the prediction value calculation means adds the prediction error to the prediction value that is based on the intra prediction direction, and generates a new prediction value.

According to this invention, in any of the moving image coding devices in (1) to (8), the prediction error is added to the prediction value that is based on the intra prediction direction, and a new prediction value is generated. For this reason, a new prediction value can be generated with an easy operation.

(10) Regarding any of the moving image coding devices in (1) to (9), the present invention proposes a moving image coding device in which, regarding prediction values of pixels corresponding to a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, the prediction value feature amount calculation means uses an average value of the prediction values of the respective pixels in the tap as the feature amount.

According to this invention, in any of the moving image coding devices in (1) to (9), regarding the prediction values of pixels corresponding to a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, an average value of the prediction values of the respective pixels in this tap can be used as the feature amount.

(11) Regarding any of the moving image coding devices in (1) to (9), the present invention proposes a moving image coding device in which the prediction value feature amount calculation means uses, as the feature amount, a value obtained by multiplying an average value of prediction values of respective pixels in a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from the reference pixel to the pixel whose feature amount is to be calculated.

According to this invention, in any of the moving image coding devices in (1) to (9), it is possible to use, as the feature amount, the value obtained by multiplying the average value of the prediction values of pixels in a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from the reference pixel to the pixel whose feature amount is to be calculated.

(12) The invention proposes a moving image decoding device that permits generation of an intra prediction value that is based on intra prediction, including: statistic parameter determination means (corresponding, for example, to a statistic parameter determination unit 131 in FIG. 10) for estimating a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter (corresponding, for example, to the average and the variance, which will be described later) of the statistic of the prediction error; prediction value feature amount calculation means (corresponding, for example, to a prediction value feature amount calculation unit 133 in FIG. 10) for calculating, regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of a prediction value at a pixel near a pixel to be processed; and prediction value calculation means (corresponding, for example, to a second prediction value calculation unit 134 in FIG. 2) for estimating a prediction error corresponding to a distance from a reference pixel to the pixel to be processed using the parameter of the statistic obtained by the statistic parameter determination means, reflecting the prediction error in the prediction value (corresponding, for example, to an intra prediction value H in FIG 10) that is based on the intra prediction direction using the feature amount calculated by the prediction value feature amount calculation means, and generating a new prediction value (corresponding, for example, to an intra prediction value E).

According to this invention, the statistic of the prediction error is estimated using the approximated value of the statistic parameter of the prediction error that is based on the intra prediction direction. Regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of the prediction value at a pixel near the pixel to be processed is calculated. Furthermore, the prediction error corresponding to the distance from the reference pixel to the pixel to be processed is estimated using the aforementioned statistic parameter, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated.

For this reason, the prediction value that is based on the intra prediction direction can be corrected using the statistic that expresses the occurrence frequency of a change in the pixel value for each distance from the reference pixel located along the intra prediction direction. Accordingly, the change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value that is based on the intra prediction direction.

Also, the control information necessary for generating a new prediction value is only an approximated value of the statistic parameter. For this reason, an increase in the control information to be provided to each processing block can be suppressed.

With the above-described configuration, in the intra prediction, the bit rate can be suppressed without decreasing video quality, and accordingly, compression performance can be improved.

(13) Regarding the moving image decoding device in (12), the present invention proposes a moving image decoding device in which the statistic parameter determination means uses, as the statistic, a Laplace distribution expression with respect to a histogram of the prediction error.

According to this invention, in the moving image decoding device in (12), a Laplace distribution expression with respect to a histogram of the prediction error can be used as the statistic.

(14) Regarding the moving image decoding device in (13), the present invention proposes a moving im-

age decoding device in which the statistic parameter determination means uses, as the parameter of the statistic, an average and a variance of the Laplace distribution.

According to this invention, in the moving image decoding device in (13), an average and a variance of a Laplace distribution can be used as parameters of the statistic.

(15) Regarding any of the moving image decoding devices in (12) to (14), the present invention proposes a moving image decoding device in which the prediction value calculation means estimates the prediction error using the parameter of the statistic, compares magnitudes of feature amounts calculated for pixels (corresponding, for example, to pixels in the first segment in FIG. 4) whose distance from the reference pixel is no smaller than a predetermined lower limit value and is smaller than a predetermined upper limit value by the prediction value feature amount calculation means among pixels in a processing block, and determines a pixel for reflecting the prediction error in a prediction value thereof from among the pixels in the processing block, based on a magnitude of the feature amount.

According to this invention, in any of the moving image decoding devices in (12) to (14), the pixel for reflecting the prediction error in the prediction value thereof from among the pixels in the processing block is determined based on the magnitude of the feature amount. For this reason, the change in the pixel value, in which pixel value correlation among the pixels in a processing block is considered, can be reflected in the prediction value of an appropriate pixel.

(16) Regarding the moving image decoding device in (15), the present invention proposes a moving image decoding device in which the prediction value calculation means has, in advance, a plurality of rules that define how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof, and selects one of the plurality of rules for each processing block, and determines the pixel for reflecting the prediction error in the prediction value thereof, in accordance with the selected rule.

According to this invention, in the moving image decoding device in (15), one of the plurality of rules is selected for each processing block, and the pixel for reflecting the prediction error in the prediction value thereof is determined in accordance with the selected rule. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel by selecting a rule that corresponds to the image.

(17) Regarding the moving image decoding device in (16), the present invention proposes a moving image decoding device in which the prediction value calculation means has, as the plurality of rules, a rule for reflecting a large prediction error in a pixel having a large feature amount, and a rule for reflecting a large prediction error in a pixel having a small feature amount.

According to this invention, in the moving image decoding device in (16), a rule for reflecting a large prediction error in a pixel having a large feature amount and a rule for reflecting a large prediction error in a pixel having a small feature amount are provided as the rules that define how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel by selecting these two rules as appropriate.

(18) Regarding any of the moving image decoding devices in (12) to (17), the present invention proposes a moving image decoding device in which the prediction value calculation means adds the prediction error to the prediction value that is based on the intra prediction direction, and generates a new prediction value.

According to this invention, in any of the moving image decoding devices in (12) to (17), the prediction error is added to the prediction value that is based on the intra prediction direction, and a new prediction value is generated. For this reason, a new prediction value can be generated with an easy operation.

(19) Regarding the moving image decoding devices in (12) to (18), the present invention proposes a moving image decoding device in which, regarding prediction values of pixels corresponding to a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, the prediction value feature amount calculation means uses an average value of the prediction values of the respective pixels in the tap as the feature amount.

According to this invention, in the moving image decoding devices in (12) to (18), regarding the prediction values of pixels corresponding to the diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, an average value of the prediction values of the respective pixels in this tap can be used as the feature amount.

(20) Regarding the moving image decoding devices in (12) to (19), the present invention proposes a moving image decoding device in which the prediction value feature amount calculation means uses, as the feature amount, a value obtained by multiplying an average value of prediction values of respective pixels in a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from the reference pixel to the pixel whose feature amount is to be calculated.

According to this invention, in the moving image decoding devices in (12) to (19), it is possible to use, as the feature amount, a value obtained by multiplying an average value of prediction values of pixels in a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from the reference pixel to the pixel whose feature amount is to be calculated.

(21) The invention proposes a method for coding a moving image in a moving image coding device that includes prediction error statistic evaluation means (corresponding, for example, to the prediction error statistic evaluation unit 30 in FIG. 2), prediction value feature amount calculation means (corresponding, for example, to the prediction value feature amount calculation unit 40 in FIG. 2), and prediction value calculation means (corresponding, for example, to the second prediction value calculation unit 50 in FIG. 2), and permits generation of an intra prediction value that is based on an intra prediction direction, the method including: a first step in which the prediction error statistic evaluation means expresses, as a parameter, a statistic of a prediction error that is based on the intra prediction direction, and approximates the parameter (corresponding, for example, to the average and the variance, which will be described later) of the statistic in accordance with a distance from a reference pixel located along the intra prediction direction to a pixel to be processed; a second step in which the prediction value feature amount calculation means calculates, for a pixel near the pixel to be processed, a feature amount of a prediction value that is based on the intra prediction direction; and a third step in which the prediction value calculation means estimates a prediction error corresponding to the distance from the reference pixel located along the intra prediction direction to the pixel to be processed using the parameter of the statistic approximated by the first step, reflects the prediction error in the prediction value (corresponding, for example, to the intra prediction value k in FIG. 2) that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value (corresponding, for example, to the intra prediction value d in FIG. 2).

According to this invention, the statistic of the prediction error that is based on the intra prediction direction is expressed as a parameter, and the statistic parameter is approximated in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed. Also, a feature amount of the prediction value that is based on the intra prediction direction is calculated for a pixel near the pixel to be processed. Furthermore, the prediction error corresponding to the aforementioned distance is estimated using the approximated statistic parameter, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated. Accordingly, an effect similar to the aforementioned effect can be achieved.

(22) The invention proposes a method for decoding a moving image in a moving image decoding device that includes statistic parameter determination means (corresponding, for example, to the statistic parameter determination unit 131 in FIG. 10), prediction value feature amount calculation means (corresponding, for example, to the prediction value feature amount calculation unit 133 in FIG. 10), and prediction value calculation means (corresponding, for example, to the second prediction value calculation unit 134 in FIG. 2), and permits generation of an intra prediction value that is based on intra prediction, the method including: a first step in which the statistic parameter determination means estimates a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter (corresponding, for example, to the average and the variance, which will be described later) of the statistic of the prediction error; a second step in which the prediction value feature amount calculation means calculates, regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of a prediction value at a pixel near a pixel to be processed; and a third step in which the prediction value calculation means estimates a prediction error corresponding to a distance from a reference pixel to the pixel to be processed using the parameter of the statistic obtained by the first step, reflects the prediction error in a prediction value (corresponding, for example, to the intra prediction value H in FIG 10) that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value (corresponding, for example, to the intra prediction value E in FIG. 10).

According to this invention, the statistic of the prediction error is estimated using the approximated value of the parameter of the statistic of the prediction error that is based on the intra prediction direction. Regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of the prediction value at a pixel near the pixel to be processed is calculated. Furthermore, the prediction error corresponding to the distance from the reference pixel to the pixel to be processed is estimated using the aforementioned statistic parameter, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated. Accordingly, an effect similar to the aforementioned effect can be achieved.

(23) The invention proposes a program for causing

a computer to execute a method for coding a moving image in a moving image coding device that includes prediction error statistic evaluation means (corresponding, for example, to the prediction error statistic evaluation unit 30 in FIG. 2), prediction value feature amount calculation means (corresponding, for example, to the prediction value feature amount calculation unit 40 in FIG. 2), and prediction value calculation means (corresponding, for example, to the second prediction value calculation unit 50 in FIG. 2), and permits generation of an intra prediction value that is based on an intra prediction direction, the program including: a first step in which the prediction error statistic evaluation means expresses, as a parameter, a statistic of a prediction error that is based on the intra prediction direction, and approximates the parameter (corresponding, for example, to the average and the variance, which will be described later) of the statistic in accordance with a distance from a reference pixel located along the intra prediction direction to a pixel to be processed; a second step in which the prediction value feature amount calculation means calculates, for a pixel near the pixel to be processed, a feature amount of a prediction value that is based on the intra prediction direction; and a third step in which the prediction value calculation means estimates a prediction error corresponding to the distance from the reference pixel located along the intra prediction direction to the pixel to be processed using the parameter of the statistic approximated by the first step, reflects the prediction error in the prediction value (corresponding, for example, to the intra prediction value k in FIG. 2) that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value (corresponding, for example, to the intra prediction value d in FIG. 2). According to this invention, the statistic of the prediction error that is based on the intra prediction direction is expressed as a parameter, and the statistic parameter is approximated in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed, by executing the program using the computer. Also, a feature amount of the prediction value that is based on the intra prediction direction is calculated for a pixel near the pixel to be processed. Furthermore, the prediction error corresponding to the aforementioned distance is estimated using the approximated statistic parameter, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated. Accordingly, an effect similar to the aforementioned effect can be achieved.

(24) The invention proposes a program for causing a computer to execute a method for decoding a moving image in a moving image decoding device that includes statistic parameter determination means (corresponding, for example, to the statistic parameter determination unit 131 in FIG. 10), prediction value feature amount calculation means (corresponding, for example, to the prediction value feature amount calculation unit 133 in FIG. 10), and prediction value calculation means (corresponding, for example, to the second prediction value calculation unit 134 in FIG. 2), and permits generation of an intra prediction value that is based on intra prediction, the program including: a first step in which the statistic parameter determination means estimates a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter (corresponding, for example, to the average and the variance, which will be described later) of the statistic of the prediction error; a second step in which the prediction value feature amount calculation means calculates, regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of a prediction value at a pixel near a pixel to be processed; and a third step in which the prediction value calculation means estimates a prediction error corresponding to a distance from a reference pixel to the pixel to be processed using the parameter of the statistic obtained by the first step, reflects the prediction error in a prediction value (corresponding, for example, to the intra prediction value H in FIG 10) that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value (corresponding, for example, to the intra prediction value E in FIG. 10).

[0011] According to this invention, the statistic of the prediction error is estimated using the approximated value of the statistic parameter of the prediction error that is based on the intra prediction direction by executing the program using the computer. Regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of the prediction value at a pixel near the pixel to be processed is calculated. Furthermore, the prediction error corresponding to the distance from the reference pixel to the pixel to be processed is estimated using the aforementioned statistic parameter, the prediction error is reflected in the prediction value that is based on the intra prediction direction using the calculated feature amount, and a new prediction value is generated. Accordingly, an effect similar to the aforementioned effect can be achieved.

EFFECTS OF THE INVENTION

[0012] According to the present invention, compression performance improve compression is improved.

BRIEF DESCRIPTION OF DRAWINGS

[0013]

FIG. 1 is a block diagram of a moving image coding device according to a first embodiment of the present invention;

FIG. 2 is a block diagram of an intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 3 is a block diagram of a prediction error statistic evaluation unit provided in the intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 4 is a diagram for illustrating operations of the intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 5 is a diagram for illustrating operations of the intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 6 is a diagram for illustrating operations of the intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 7 is a diagram for illustrating operations of the intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 8 is a diagram for illustrating operations of the intra prediction value generation unit included in the moving image coding device according to the aforementioned embodiment;

FIG. 9 is a block diagram of a moving image decoding device according to the first embodiment of the present invention;

FIG. 10 is a block diagram of an intra prediction value generation unit included in the moving image decoding device according to the aforementioned embodiment;

FIG. 11 is a block diagram of an intra prediction value generation unit included in a moving image coding device according to a second embodiment of the present invention; and

FIG. 12 is a block diagram of the intra prediction value generation unit included in a moving image decoding device according to the second embodiment of the present invention.

MODE FOR CARRYING OUT THE INVENTION

[0014] Hereinafter, modes for carrying out the present invention will be described with reference to the drawings. Note that constituent elements in the following embodiments can be replaced with existing constituent elements or the like as appropriate, and various variations including combinations with other existing constituent elements are possible. Accordingly, the descriptions of the following embodiments do not limit the content of the invention stated in the claims.

[0015] <First Embodiment>

[Configuration and operations of moving image coding device AA]

[0016] FIG. 1 is a block diagram of a moving image coding device AA according to a first embodiment of the present invention. The moving image coding device AA includes an intra prediction value generation unit 1, an inter prediction value generation unit 2, a DCT/quantization unit 3, an inverse DCT/inverse quantization unit 4, an entropy coding unit 5, and a local memory 6.

[0017] An input image a and a later-described coded image j that is supplied from the local memory 6 are input to the intra prediction value generation unit 1. This intra prediction value generation unit 1 generates a prediction value based on intra prediction and outputs this prediction value as an intra prediction value d, and also outputs control information (such as an intra prediction direction) c regarding the intra prediction.

[0018] The input image a and the later-described coded image j that is supplied from the local memory 6 are input to the inter prediction value generation unit 2. This inter prediction value generation unit 2 generates a prediction value based on inter prediction, outputs this prediction value as an inter prediction value e, and also outputs control information (such as a motion vector) f regarding the inter prediction.

[0019] A prediction residual signal is input to the DCT/quantization unit 3. The prediction residual signal is a difference signal between the input image a and a prediction value g, and the prediction value g is one of the intra prediction value d and the inter prediction value e that is obtained by a prediction method expected to achieve higher coding performance. This DCT/quantization unit 3 performs orthogonal transform processing on the prediction residual signal, performs quantization processing on a transform coefficient obtained by this orthogonal transform processing, and outputs a quantized transform coefficient h.

[0020] The quantized transform coefficient h is input to the inverse DCT/inverse quantization unit 4. This inverse DCT/inverse quantization unit 4 performs inverse quantization processing on the quantized transform coefficient h, performs inverse transform processing on a transform coefficient obtained by this inverse quantization processing, and outputs an inverse orthogonal-transformed transform coefficient i.

[0021] The control information c regarding the intra prediction, the control information f regarding the inter prediction, and the quantized transform coefficient h are input to the entropy coding unit 5. This entropy coding unit 5 performs entropy coding processing on the above input information, describes a result thereof in coded data in accordance with a rule (coding syntax) of description in coded data, and outputs this data as coded data b.

[0022] The coded image j is input to the local memory 6. This local memory 6 accumulates the input coded image j, and supplies the coded image j to the intra prediction value generation unit 1 and the inter prediction value generation unit 2 as appropriate in the case where a past coded image j needs to be referenced for the next and subsequent coding processing unit blocks. The coded image j refers to a signal obtained by adding the prediction value g and the inverse orthogonal-transformed transform coefficient i.

(Configuration and operations of intra prediction value generation unit 1)

[0023] FIG. 2 is a block diagram of the intra prediction value generation unit 1. The intra prediction value generation unit 1 includes a prediction direction determination unit 10, a first prediction value calculation unit 20, a prediction error statistic evaluation unit 30, a prediction value feature amount calculation unit 40, and a second prediction value calculation unit 50.

[0024] The input image a and the coded image j are input to the prediction direction determination unit 10. This prediction direction determination unit 10 determines a prediction direction in which prediction can be most appropriately performed with respect to the input image a and the coded image j from among a plurality of predetermined intra prediction directions, and outputs the determined prediction direction as an intra prediction direction c1.

[0025] The coded image j and an intra prediction direction c1 are input to the first prediction value calculation unit 20. This first prediction value calculation unit 20 references a pixel value of the coded image j and calculates and outputs an intra prediction value k in accordance with the intra prediction direction c1.

[0026] The input image a, the intra prediction direction c1, and the intra prediction value k are input to the prediction error statistic evaluation unit 30. This prediction error statistic evaluation unit 30 initially obtains an intra prediction residual from the input image a and the intra prediction value k, evaluates a statistic regarding the obtained intra prediction residual, and parametrically expresses this statistic. Next, the prediction error statistic evaluation unit 30 obtains an approximation function expressing the relationship between the statistic parameter and the distance from a reference pixel located along the intra prediction direction c1, and obtains and outputs a parameter approximation coefficient c2 based on a coefficient of the approximation function. The parameter approximation coefficient c2 and the intra prediction direction c1 are output as the aforementioned control information c regarding the intra prediction from the intra prediction value generation unit 1. Next, the prediction error statistic evaluation unit 30 outputs a statistic obtained from the obtained approximation coefficient as a statistic m. The above-described prediction error statistic evaluation unit 30 will be described below in detail using FIG. 3.

(Configuration and operations of prediction error statistic evaluation unit 30)

[0027] FIG. 3 is a block diagram of the prediction error statistic evaluation unit 30. The prediction error statistic evaluation unit 30 includes a prediction error calculation unit 31, a statistic parameter calculation unit 32, a parameter approximation unit 33, and a parameter determination unit 34.

[0028] The input image a and the intra prediction value k are input to the prediction error calculation unit 31. This prediction error calculation unit 31 calculates, for each pixel, a differential value between the input image a and the intra prediction value k, and outputs the calculated differential value as an intra prediction error p.

[0029] The intra prediction direction c1 and the intra prediction error p are input to the statistic parameter calculation unit 32. This statistic parameter calculation unit 32 initially calculates, for each pixel in the processing block, the distance to the pixel from the reference pixel located along the intra prediction direction c1. Next, the statistic parameter calculation unit 32 classifies each pixel in the processing block into T kinds (T is an integer that is no smaller than 2) of segments in accordance with the calculated distance, and generates a histogram expressing the occurrence frequency of the intra prediction error for each segment. Next, the statistic parameter calculation unit 32 expresses the generated histogram as a distribution, and in the present embodiment, a Laplace distribution is applied as this distribution. Next, the statistic parameter calculation unit 32 calculates an average and a variance in each segment, and outputs the calculated average and variance as statistic parameters q in each segment.

[0030] The statistic parameters q in each segment are input to the parameter approximation unit 33. This parameter approximation unit 33 initially approximates, for each of the statistic parameters q (the average and the variance in the present embodiment) in each segment, the relationship between the distance from the reference pixel and the statistic parameter by means of linear approximation or polynomial approximation. Next, the parameter approximation unit 33 quantizes a coefficient of the obtained approximation function in accordance with a predetermined quantization step width, and outputs the quantized coefficient as a parameter approximation coefficient c2.

[0031] The parameter approximation coefficient c2 is input to the parameter determination unit 34. This parameter determination unit 34 initially inversely quantizes the parameter approximation coefficient c2 in accordance with the predetermined quantization step width, and derives an approximation function for each type of statistic parameter (the average and the variance in the present embodiment) using the obtained approximation coefficient. Next, the parameter determination unit 34 obtains an estimated value of the statistic parameter in accordance with the distance from the reference pixel using the derived approximation function, and outputs the obtained estimated value as the statistic m.

[0032] Returning to FIG. 2, the intra prediction value k is input to the prediction value feature amount calculation unit 40. This prediction value feature amount calculation unit 40 calculates a feature amount regarding the intra prediction value k with respect to every pixel in the processing block, and outputs the calculated feature amount as a feature amount n.

[0033] Specifically, the prediction value feature amount calculation unit 40 initially calculates, with respect to each pixel in the processing block, a feature amount that is based on prediction values of pixels corresponding to a rhombus tap with the pixel to be processed as the center, and outputs the calculated feature amount as the feature amount n. The following two types can be taken as examples of the feature amount to be calculated, for example. The first one is a result of averaging prediction values of target pixels within a region corresponding to the tap. The second one is a result of multiplying the average value of the prediction values of the pixels corresponding to the tap by a weighting coefficient corresponding to the distance from the reference pixel.

[0034] The intra prediction direction c1, the intra prediction value k, the statistic m, and the feature amount n are input to the second prediction value calculation unit 50. This second prediction value calculation unit 50 initially obtains the distance from the reference pixel located along the intra prediction direction c1 based on the intra prediction direction c1 and the statistic m. Next, the second prediction value calculation unit 50 calculates a statistic of an estimated prediction error based on the distance from the reference pixel located along the intra prediction direction, reflects the calculated prediction error statistic in the intra prediction value k, generates a new intra prediction value, and outputs the generated intra prediction value as the intra prediction value d.

[0035] Specifically, the second prediction value calculation unit 50 initially classifies the processing block into T kinds of segments in accordance with the distance from the reference pixel located along the intra prediction direction c1 based on the intra prediction direction c1 and the statistic m, and generates a histogram related to the prediction error for each segment based on the statistic m for each distance from the reference pixel. Here, the magnitudes of feature amounts in the same segment are compared based on the feature amount n, and larger feature amounts are sequentially associated with pixels whose class (prediction error) in the histogram is higher. Next, all pixels in the processing block are associated with the prediction error distribution, the prediction error distribution corresponding to each pixel is added to the intra prediction value k, and a result thereof is used as the intra prediction value d.

(Prediction value generation by intra prediction value generation unit 1)

[0036] Prediction value generation by the intra prediction value generation unit 1 will be described below using FIGS. 4 to 8.

[0037] The intra prediction value generation unit 1 initially determines the intra prediction direction for the processing block using the prediction direction determination unit 10, and calculates the intra prediction value using the first prediction value calculation unit 20. It is assumed below that the intra prediction direction for the processing block has been determined to be a vertical direction.

[0038] FIG. 4 is a diagram showing the processing block. The block size of the processing block is 16×16. The intra prediction value generation unit 1 initially classifies the processing block into four types of segments in a direction perpendicular to the intra prediction direction in accordance with the distance from the reference pixel to each pixel, using the statistic parameter calculation unit 32.

[0039] Next, the intra prediction value generation unit 1 calculates a differential value between the input image and the intra prediction value for each pixel and obtains the intra prediction residual as shown in FIG. 5, using the prediction error calculation unit 31. FIG. 5 shows the pixel values of the input image, the intra prediction values, and the intra prediction residuals in a first segment shown in FIG. 4. Note that the following description describes the case where prediction value generation by the intra prediction value generation unit 1 is performed for the first segment.

[0040] Next, the intra prediction value generation unit 1 generates a histogram of intra prediction errors for each segment, and obtains an average μ and a distribution φ of the intra prediction residuals in each segment, using the statistic parameter calculation unit 32. FIG. 6 shows the histograms of the intra prediction residuals, the averages, and the distributions in the first segment and a second segment.

[0041] Next, with segment numbers "1", "2", "3", and "4" assigned respectively to the first segment, the second segment, a third segment, and a fourth segment, the intra prediction value generation unit 1 approximates the averages μ and the distributions φ by means of linear approximation with the segment number as a variable x, using the parameter approximation unit 33. Then, as shown in FIG. 6, a linear approximation function for the average μ and a linear approximation function for the distribution φ are obtained.

[0042] Next, the intra prediction value generation unit 1 quantizes coefficients (0.000 and 0.9846) of the linear approximation function for the average μ and coefficients (0.0234 and 1.7487) of the linear approximation function for the distribution φ using the parameter approximation unit 33. A result of the quantization (the parameter approximation coefficient c2) is coded by the entropy coding unit 5 and transmitted to a later-described moving image decoding device BB.

[0043] Next, the intra prediction value generation unit 1 inversely quantizes the result of the quantization performed by the parameter approximation unit 33 using the parameter determination unit 34, derives the approximation function for the average μ and the approximation function for the distribution φ, and calculates estimated values of the average μ and the distribution φ using the derived approximation functions. Then, as shown in FIG. 7, 0.9846 is obtained as the estimated value of the average μ, and 1.7721 is obtained as the estimated value of the distribution φ. FIG. 7 shows the estimated values of the average μ and the distribution φ calculated using the approximation function, and a Laplace distribution graph calculated from these estimated values.

[0044] Next, the intra prediction value generation unit 1 calculates a feature amount using the prediction value feature amount calculation unit 40. The calculation of the feature amount uses an intra prediction value for a pixel in the processing block, a decoded pixel value for a coded pixel outside the processing block, and a value obtained by extrapolating the intra prediction value for a pixel that is outside the processing block and has not been coded. A filter with which all taps are equally weighted is used for the diamond-shaped taps each constituted by 7×7 pixels with a pixel whose feature amount is to be calculated as the center.

[0045] Next, the intra prediction value generation unit 1 calculates a prediction error statistic such that the histogram in each segment coincides with the Laplace distribution calculated from the estimated values of the average μ and the distribution φ, using the second prediction value calculation unit 50. Also, pixels are allocated to prediction error statistics such that a pixel with a smaller feature amount is given a larger prediction error statistic. Then, the allocated prediction error statistic is added to the intra prediction value k for each pixel, and the intra prediction value d is obtained.

[0046] The aforementioned allocation will be described below using FIG. 8. In the first segment, the frequency of the smallest class "-5" is 1, the frequency of the class "-4" is 1, and the frequency of the class "-3" is 2. For this reason, in the first segment, the number of pixels having the prediction error statistics "-5", "-4", and "-3" are set respectively to 1, 1, and 2. Specifically, the prediction error statistics "-5", "-4", and "-3" are allocated respectively to the pixel having the smallest feature amount in the first segment, the pixel having the second smallest feature amount, and the pixels having the third and fourth smallest feature amounts.

[0047] Note that in FIGS. 4 to 8, the intra prediction direction for the processing block is set to a vertical direction, and accordingly the number of pixels included respectively in the first to fourth segments are the same, whereas in the case where the intra prediction direction for the processing block is set to an oblique direction, for example, the number of pixels to be included in the respective segments are different. However, even if the number of pixels included in the respective segments are different, there is no particular problem since prediction value generation in the segments is performed independently for each segment using the statistics (the average μ and the distribution φ) related to the intra prediction residual of each segment.

[Configuration and operations of moving image decoding device BB]

[0048] FIG. 9 is a block diagram of a moving image decoding device BB according to the first embodiment of the present invention. The moving image decoding device BB includes an entropy decoding unit 110, an inverse DCT/inverse quantization unit 120, an intra prediction value generation unit 130, an inter prediction value generation unit 140, and a local memory 150.

[0049] The coded data b is input to the entropy decoding unit 110. This entropy decoding unit 110 analyzes the content described in the coded data b in accordance with a coded data structure, performs entropy decoding, and acquires and outputs a residual signal B and control information C for inter prediction or intra prediction.

[0050] The residual signal B is input to the inverse DCT/inverse quantization unit 120. This inverse DCT/inverse quantization unit 120 performs inverse quantization processing on the residual signal B, performs inverse transform processing on a result of the inverse quantization processing, and outputs a result of the inverse transform processing as an inverse orthogonal transform result D.

[0051] A later-described decoded image A that is supplied from the local memory 150 and the control information C for prediction are input to the intra prediction value generation unit 130. This intra prediction value generation unit 130 obtains the intra prediction direction based on the control information C for prediction, references the pixel value of the decoded image A in accordance with the obtained intra prediction direction, and generates and outputs an intra prediction value E.

[0052] The later-described decoded image A that is supplied from the local memory 150 and the control information C for prediction are input to the inter prediction value generation unit 140. This inter prediction value generation unit 140 obtains a motion vector based on the control information for prediction, references the pixel value of the decoded image A in accordance with the obtained motion vector, and generates and outputs an inter prediction value F.

[0053] The decoded image A is input to the local memory 150. This local memory 150 accumulates the input decoded image A, and supplies the accumulated decoded image A to the intra prediction value generation unit 130 and the inter prediction value generation unit 140 as appropriate in the case where a past decoded image A needs to be referenced for the next and subsequent decoding processing unit blocks. The decoded image A refers to a signal obtained by adding the inverse orthogonal transform result D and the intra prediction value E or the inter prediction value F.

(Configuration and operations of intra prediction value generation unit 130)

[0054] FIG. 10 is a block diagram of the intra prediction value generation unit 130. The intra prediction value generation unit 130 includes a statistic parameter determination unit 131, a first prediction value calculation unit 132, a prediction value feature amount calculation unit 133, and a second prediction value calculation unit 134.

[0055] A quantized approximation coefficient C1 is input to the statistic parameter determination unit 131. The quantized approximation coefficient C1 is information included in the control information C for prediction. This statistic parameter determination unit 131 initially inversely quantizes the quantized approximation coefficient C1 in accordance with a predetermined quantization step, and derives an approximation function for each type of statistic parameter (the average and the variance). Next, the statistic parameter determination unit 131 obtains a statistic parameter corresponding to the distance from the reference pixel using the obtained approximation function, and outputs the obtained statistic parameter as a statistic G.

[0056] The decoded image A and an intra prediction direction C2 are input to the first prediction value calculation unit 132. The intra prediction direction C2 is information included in the control information C for prediction. This first prediction value calculation unit 132 references a pixel value of the decoded image A in accordance with the intra prediction direction C2, and generates and outputs an intra prediction value H in the processing block.

[0057] The intra prediction value H is input to the prediction value feature amount calculation unit 133. This prediction value feature amount calculation unit 133 calculates a feature amount that is based on prediction values of pixels corresponding to a rhombus tap with the pixel to be processed as the center for each pixel in the processing block, and outputs the calculated feature amount as a feature amount I. The following two types can be taken as examples of the feature amount to be calculated, for example. The first one is a result of averaging prediction values of target pixels within a region corresponding to the tap. The second one is a result of multiplying the average value of the prediction values of the pixels corresponding to the tap by a weighting coefficient corresponding to the distance from the reference pixel.

[0058] The intra prediction direction C2, the statistic G, the intra prediction value H, and the feature amount I are input to the second prediction value calculation unit 134. This second prediction value calculation unit 134 initially calculates, for each pixel in the processing block, the distance to the pixel from the reference pixel located along the intra prediction direction C2. Next, the second prediction value calculation unit 134 classifies each pixel in the processing block into T kinds of segments in accordance with the calculated distance, and generates a histogram expressing the occurrence frequency of the intra prediction error for each segment. Here, the magnitudes of the feature amounts in the same segments are compared based on the feature amount I, and larger feature amounts are sequentially associated with pixels whose class (prediction error) in the histogram is higher. Next, all pixels in the processing block are associated with the prediction error distribution, the prediction error distribution corresponding to each pixel is added to the intra prediction value H, and a result thereof is used as the intra prediction value E.

[0059] With the above-described moving image coding device AA and moving image decoding device BB, the following effect can be achieved.

[0060] The moving image coding device AA and the moving image decoding device BB each express, as a statistic, the occurrence frequency of a change in the pixel value for each distance from a reference pixel located along the intra prediction direction, and correct a prediction value that is based on the intra prediction direction using this statistic. For this reason, the change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value that is based on the intra prediction direction.

[0061] In addition, the control information necessary for expressing a new generated prediction value is only the average μ and the distribution φ. For this reason, an increase in the control information to be provided to each processing block can be suppressed.

[0062] With the above-described configuration, in the intra prediction, the bit rate can be suppressed without decreasing video quality, and accordingly, compression performance can be improved.

[0063] The moving image coding device AA and the moving image decoding device BB each can use a Laplace distribution expression with respect to a histogram of the prediction error as a statistic, and use an average and a variance of the Laplace distribution as parameters of the statistic.

[0064] The moving image coding device AA and the moving image decoding device BB each determine, based on the magnitude of the feature amount, a pixel for reflecting the prediction error in the prediction value thereof from among the pixels in the processing block. For this reason, the change in the pixel value, in which pixel value correlation among the pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel.

[0065] The moving image coding device AA and the moving image decoding device BB each add the prediction error to the prediction value that is based on the intra prediction direction, and generate new prediction values. For this reason, a new prediction value can be generated with an easy operation.

[0066] The moving image coding device AA and the moving image decoding device BB each can use, regarding prediction values of pixels corresponding to a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, an average value of the prediction values of the respective pixels in this tap as the feature amount, and use a value obtained by multiplying the average value of the prediction values of the pixels in the diamond-shaped tap with the pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from a reference pixel to the pixel whose feature amount is to be calculated as the feature amount.

[0067] <Second Embodiment>

[Configuration and operations of moving image coding device CC]

[0068] A moving image coding device CC according to a second embodiment of the present invention will be described below. The moving image coding device CC is different from the moving image coding device AA according to the first embodiment of the present invention shown in FIG. 1 in that an intra prediction value generation unit 1A is provided in place of the intra prediction value generation unit 1. Note that the same constituent elements of the moving image coding device CC as those of the moving image coding device AA will be assigned the same signs, and descriptions thereof will be omitted.

(Configuration and operations of intra prediction value generation unit 1A)

[0069] FIG. 11 is a block diagram of the intra prediction value generation unit 1A. The intra prediction value generation unit 1A is different from the intra prediction value generation unit 1 according to the first embodiment of the present invention shown in FIG. 2 in that a second prediction value calculation unit 50A is provided in place of the second prediction value calculation unit 50.

[0070] The intra prediction direction c1, the intra prediction value k, the statistic m, and the feature amount n are input to the second prediction value calculation unit 50A. This second prediction value calculation unit 50A initially obtains the distance from a reference pixel located along the intra prediction direction based on the intra prediction direction c1 and the statistic m. Next, the second prediction value calculation unit 50 calculates a statistic of an estimated prediction error based on the distance from the reference pixel located along the intra prediction direction, reflects the calculated prediction error statistic in the intra prediction value k, generates a new intra prediction value, and outputs the generated intra prediction value as the intra prediction value d. Also, the second prediction value calculation unit 50A outputs predetermined information for generating the intra prediction value d as sequence identification information c3.

[0071] Specifically, the second prediction value calculation unit 50A initially classifies the processing block into T kinds of segments in accordance with the distance from the reference pixel located along the intra prediction direction c1 based on the intra prediction direction c1 and the statistic m, and generates a histogram related to the prediction error for each segment based on the statistic m for each distance from the reference pixel. Here, the magnitudes of the feature amounts are compared in the same segment based on the feature amount n, the most appropriate rule is determined from among a plurality of predetermined rules between the moving image coding device CC and a later-described moving image decoding device DD, and a histogram class (prediction error) is allocated to each pixel in accordance with the determined rule. Information indicating the rule used in this allocation is output as the sequence identification information c3. Next, all pixels in the processing block are associated with the prediction error distribution, the prediction error distribution corresponding to each pixel is added to the intra prediction value k, and a result thereof is used as the intra prediction value d.

[0072] Note that in each of the aforementioned plurality of predetermined rules, a rule that provides a way to associate the magnitude of the feature amount with the histogram class is defined. It is assumed that, for example, the aforementioned plurality of rules include a rule for allocating a high histogram class to a pixel having a large feature amount, a rule for allocating a high histogram class to a pixel having a small feature amount, and the like. Then, the second prediction value calculation unit 50A selects one of the plurality of rules that is most appropriate for coding performance for each processing block.

[0073] Also, the sequence identification information c3 is output as the aforementioned control information c regarding the intra prediction from the intra prediction value generation unit 1A together with the parameter approximation coefficient c2 and the intra prediction direction c1.

[Configuration and operations of moving image decoding device DD]

[0074] The moving image decoding device DD according to the second embodiment of the present invention will be described below. The moving image decoding device DD is different from the moving image decoding device BB according to the first embodiment of the present invention shown in FIG. 9 in that an intra prediction value generation unit 130A is provided in place of the intra prediction value generation unit 130. Note that the same constituent elements of the moving image decoding device DD as those of the moving image decoding device BB are assigned the same signs, and descriptions thereof will be omitted.

(Configuration and operations of intra prediction value generation unit 130A)

[0075] FIG. 12 is a block diagram of the intra prediction value generation unit 130A. The intra prediction value generation unit 130A is different from the intra prediction value generation unit 130 according to the first embodiment of the present invention shown in FIG. 10 in that a second prediction value calculation unit 134A is provided in place of the second prediction value calculation unit 134.

[0076] The intra prediction direction C2, the sequence identification information C3, the statistic G, the intra prediction value H, and a feature amount I are input to the second prediction value calculation unit 134A. The sequence identification information C3 is information included in the control information C for prediction. This second prediction value calculation unit 134A initially calculates, for each pixel in the processing block, the distance to the pixel from the reference pixel located along the intra prediction direction. Next, the second prediction value calculation unit 134A classifies each pixel in the processing block into T kinds of segments in accordance with the calculated distance, and generates a histogram expressing the occurrence frequency of the intra prediction error for each segment. Here, the magnitudes of feature amounts are compared in the same segment based on the feature amount I, and the histogram classes (prediction error) are associated with the magnitudes of the feature amounts in accordance with a rule determined by the sequence identification information C3 from among the aforementioned plurality of predetermined rules. Next, all pixels in the processing block are associated with the prediction error distribution, the prediction error distribution corresponding to each pixel is added to the intra prediction value H, and a result thereof is used as the intra prediction value E.

[0077] With the above-described moving image coding device CC and moving image decoding device DD, the following effect can be achieved in addition to the above-described effect that can be achieved by the moving image coding device AA and the moving image decoding device BB according to the first embodiment of the present invention.

[0078] The moving image coding device CC and the moving image decoding device DD each select one of the plurality of rules for each processing block, and determine a pixel for reflecting the prediction error in the prediction value thereof in accordance with the selected rule. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel by selecting a rule that corresponds to the image.

[0079] The moving image coding device CC and the moving image decoding device DD each can use a rule for reflecting a large prediction error in a pixel having a large feature amount and a rule for reflecting a large prediction error in a pixel having a small feature amount as the rules defining how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof. For this reason, a change in the pixel value, in which pixel value correlation among pixels in the processing block is considered, can be reflected in the prediction value of an appropriate pixel by selecting these rules as appropriate.

[0080] Note that the present invention can be achieved by recording, in a computer-readable non-transitory storage medium, the processing of the moving image coding device AA/CC and the moving image decoding device BB/DD according to the present invention, and causing the moving image coding device AA/CC and the moving image decoding device BB/DD to read out and execute a program recorded in this storage medium.

[0081] Here, for example, a nonvolatile memory such as an EPROM or a flash memory, a magnetic disk such as a hard disk, a CD-ROM, or the like can be applied as the aforementioned storage medium. The program recorded in this storage medium is read out and executed by processors provided in the moving image coding device AA/CC and the moving image decoding device BB/DD.

[0082] The aforementioned program may be transmitted from the moving image coding device AA/CC and the moving image decoding device BB/DD in which this program is stored in the storage device to another computer system via a transmission medium or through transmitted waves in the transmission medium. Here, the "transmission medium" that transmits the program refers to a medium having a function of transmitting information, such as a network (communication network) including the Internet or a communication line including a telephone line.

[0083] The aforementioned program may be for achieving some of the above-described functions. Furthermore, the aforementioned program may be one that can achieve the above-described functions in combination with a program that is already recorded in the moving image coding device AA/CC and the moving image decoding device BB/DD, i.e., a so-called differential file (differential program).

[0084] Although the embodiments of the present invention have been described in detail with reference to the drawings, the detailed configurations are not limited to these embodiments, and also include designs in the scope that does not depart from the gist of the invention.

DESCRIPTION OF THE REFERENCE NUMERALS

[0085]

AA, CC ... Moving image coding device
1, 1A ... Intra prediction value generation unit
10 ... Prediction direction determination unit
20 ... First prediction value calculation unit
30 ... Prediction error statistic evaluation unit
31 ... Prediction error calculation unit

32 ... Statistic parameter calculation unit
33 ... Parameter approximation unit
34 ... Parameter determination unit
40 ... Prediction value feature amount calculation unit
50, 50A ... Second prediction value calculation unit
BB, DD ... Moving image decoding device
130, 130A ... Intra prediction value generation unit
131 ... Statistic parameter determination unit
132 ... First prediction value calculation unit
133 ... Prediction value feature amount calculation unit
134, 134A ... Second prediction value calculation unit

Claims

1. A moving image coding device that permits generation of an intra prediction value that is based on an intra prediction direction, comprising:

prediction error statistic evaluation means for expressing, as a parameter, a statistic of a prediction error that is based on the intra prediction direction, and approximating the parameter of the statistic in accordance with a distance from a reference pixel located along the intra prediction direction to a pixel to be processed;
prediction value feature amount calculation means for calculating, for a pixel near the pixel to be processed, a feature amount of a prediction value that is based on the intra prediction direction; and
prediction value calculation means for estimating a prediction error corresponding to the distance from the reference pixel located along the intra prediction direction to the pixel to be processed using the parameter of the statistic approximated by the prediction error statistic evaluation means, reflecting the prediction error in the prediction value that is based on the intra prediction direction using the feature amount calculated by the prediction value feature amount calculation means, and generating a new prediction value.

2. The moving image coding device according to claim 1,
wherein the prediction error statistic evaluation means includes:

statistic parameter calculation means for evaluating the statistic of the prediction error that is based on the intra prediction direction, and parametrically expressing the statistic;
parameter approximation means for approximating a parameter of the statistic obtained by the statistic parameter calculation means using an approximation function in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed; and
parameter determination means for estimating the statistic of the prediction error that is based on the intra prediction direction using the approximation function obtained by the parameter approximation means.

3. The moving image coding device according to claim 2,
wherein the statistic parameter calculation means classifies a processing block into a plurality of divided blocks in accordance with the distance from the reference pixel located along the intra prediction direction to the pixel to be processed, and evaluates the statistic in each of the plurality of divided blocks, and the parameter approximation means approximates the parameter of the statistic by means of linear approximation or polynomial approximation with a representative value of the distance from the reference pixel to the pixel to be processed in each of the plurality of divided blocks as a variable.

4. The moving image coding device according to any of claims 1 to 3,
wherein the prediction error statistic evaluation means uses, as the statistic, a Laplace distribution expression with respect to a histogram of the prediction error.

5. The moving image coding device according to claim 4,
wherein the prediction error statistic evaluation means uses, as the parameter of the statistic, an average and a variance of the Laplace distribution.

6. The moving image coding device according to any of claims 1 to 5,
wherein the prediction value calculation means estimates the prediction error using the parameter of the statistic,
compares magnitudes of feature amounts calculated for pixels whose distance from the reference pixel is no smaller than a predetermined lower limit value and is smaller than a predetermined upper limit value by the prediction value feature amount calculation means among pixels in a processing block, and
determines a pixel for reflecting the prediction error in a prediction value thereof from among the pixels in the processing block, based on a magnitude of the feature amount.

7. The moving image coding device according to claim 6,
wherein the prediction value calculation means has,

in advance, a plurality of rules that define how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof, and
selects one of the plurality of rules for each processing block, and determines the pixel for reflecting the prediction error in the prediction value thereof, in accordance with the selected rule.

8. The moving image coding device according to claim 7,
wherein the prediction value calculation means has, as the plurality of rules, a rule for reflecting a large prediction error in a pixel having a large feature amount, and a rule for reflecting a large prediction error in a pixel having a small feature amount.

9. The moving image coding device according to any of claims 1 to 8,
wherein the prediction value calculation means adds the prediction error to the prediction value that is based on the intra prediction direction, and generates a new prediction value.

10. The moving image coding device according to any of claims 1 to 9,
wherein, regarding prediction values of pixels corresponding to a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, the prediction value feature amount calculation means uses an average value of the prediction values of the respective pixels in the tap as the feature amount.

11. The moving image coding device according to any of claims 1 to 9,
wherein the prediction value feature amount calculation means uses, as the feature amount, a value obtained by multiplying an average value of prediction values of respective pixels in a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from the reference pixel to the pixel whose feature amount is to be calculated.

12. A moving image decoding device that permits generation of an intra prediction value that is based on intra prediction, comprising:

statistic parameter determination means for estimating a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter of the statistic of the prediction error;
prediction value feature amount calculation means for calculating, regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of a prediction value at a pixel near a pixel to be processed; and
prediction value calculation means for estimating a prediction error corresponding to a distance from a reference pixel to the pixel to be processed using the parameter of the statistic obtained by the statistic parameter determination means, reflecting the prediction error in the prediction value that is based on the intra prediction direction using the feature amount calculated by the prediction value feature amount calculation means, and generating a new prediction value.

13. The moving image decoding device according to claim 12,
wherein the statistic parameter determination means uses, as the statistic, a Laplace distribution expression with respect to a histogram of the prediction error.

14. The moving image decoding device according to claim 13,
wherein the statistic parameter determination means uses, as the parameter of the statistic, an average and a variance of the Laplace distribution.

15. The moving image decoding device according to any of claims 12 to 14,
wherein the prediction value calculation means estimates the prediction error using the parameter of the statistic,
compares magnitudes of feature amounts calculated for pixels whose distance from the reference pixel is no smaller than a predetermined lower limit value and is smaller than a predetermined upper limit value by the prediction value feature amount calculation means among pixels in a processing block, and
determines a pixel for reflecting the prediction error in a prediction value thereof from among the pixels in the processing block, based on a magnitude of the feature amount.

16. The moving image decoding device according to claim 15,
wherein the prediction value calculation means has, in advance, a plurality of rules that define how to determine, based on the magnitude of the feature amount, the pixel for reflecting the prediction error in the prediction value thereof, and
selects one of the plurality of rules for each processing block, and determines the pixel for reflecting the prediction error in the prediction value thereof, in accordance with the selected rule.

17. The moving image decoding device according to claim 16,
wherein the prediction value calculation means has,

as the plurality of rules, a rule for reflecting a large prediction error in a pixel having a large feature amount, and a rule for reflecting a large prediction error in a pixel having a small feature amount.

18. The moving image decoding device according to any of claims 12 to 17,
wherein the prediction value calculation means adds the prediction error to the prediction value that is based on the intra prediction direction, and generates a new prediction value.

19. The moving image decoding device according to any of claims 12 to 18,
wherein, regarding prediction values of pixels corresponding to a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center, the prediction value feature amount calculation means uses an average value of the prediction values of the respective pixels in the tap as the feature amount.

20. The moving image decoding device according to any of claims 12 to 19,
wherein the prediction value feature amount calculation means uses, as the feature amount, a value obtained by multiplying an average value of prediction values of respective pixels in a diamond-shaped tap with a pixel whose feature amount is to be calculated as the center by a coefficient corresponding to the distance from the reference pixel to the pixel whose feature amount is to be calculated.

21. A method for coding a moving image in a moving image coding device that includes prediction error statistic evaluation means, prediction value feature amount calculation means, and prediction value calculation means, and permits generation of an intra prediction value that is based on an intra prediction direction, the method comprising:

a first step in which the prediction error statistic evaluation means expresses, as a parameter, a statistic of a prediction error that is based on the intra prediction direction, and approximates the parameter of the statistic in accordance with a distance from a reference pixel located along the intra prediction direction to a pixel to be processed;
a second step in which the prediction value feature amount calculation means calculates, for a pixel near the pixel to be processed, a feature amount of a prediction value that is based on the intra prediction direction; and
a third step in which the prediction value calculation means estimates a prediction error corresponding to the distance from the reference pixel located along the intra prediction direction to the pixel to be processed using the parameter of the statistic approximated by the first step, reflects the prediction error in the prediction value that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value.

22. A method for decoding a moving image in a moving image decoding device that includes statistic parameter determination means, prediction value feature amount calculation means, and prediction value calculation means, and permits generation of an intra prediction value that is based on intra prediction, the method comprising:

a first step in which the statistic parameter determination means estimates a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter of the statistic of the prediction error;
a second step in which the prediction value feature amount calculation means calculates, regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of a prediction value at a pixel near a pixel to be processed; and
a third step in which the prediction value calculation means estimates a prediction error corresponding to a distance from a reference pixel to the pixel to be processed using the parameter of the statistic obtained by the first step, reflects the prediction error in a prediction value that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value.

23. A program for causing a computer to execute a method for coding a moving image in a moving image coding device that includes prediction error statistic evaluation means, prediction value feature amount calculation means, and prediction value calculation means, and permits generation of an intra prediction value that is based on an intra prediction direction, the method comprising:

a first step in which the prediction error statistic evaluation means expresses, as a parameter, a statistic of a prediction error that is based on the intra prediction direction, and approximates the parameter of the statistic in accordance with a distance from a reference pixel located along the intra prediction direction to a pixel to be processed;
a second step in which the prediction value feature amount calculation means calculates, for a pixel near the pixel to be processed, a feature amount of a prediction value that is based on the intra prediction direction; and

a third step in which the prediction value calculation means estimates a prediction error corresponding to the distance from the reference pixel located along the intra prediction direction to the pixel to be processed using the parameter of the statistic approximated by the first step, reflects the prediction error in the prediction value that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value.

24. A program for causing a computer to execute a method for decoding a moving image in a moving image decoding device that includes statistic parameter determination means, prediction value feature amount calculation means, and prediction value calculation means, and permits generation of an intra prediction value that is based on intra prediction, the method comprising:

a first step in which the statistic parameter determination means estimates a statistic of a prediction error that is based on an intra prediction direction using an approximated value of a parameter of the statistic of the prediction error;
a second step in which the prediction value feature amount calculation means calculates, regarding a prediction value obtained by prediction that is based on the intra prediction direction, a feature amount of a prediction value at a pixel near a pixel to be processed; and
a third step in which the prediction value calculation means estimates a prediction error corresponding to a distance from a reference pixel to the pixel to be processed using the parameter of the statistic obtained by the first step, reflects the prediction error in a prediction value that is based on the intra prediction direction using the feature amount calculated by the second step, and generates a new prediction value.

FIG. 1

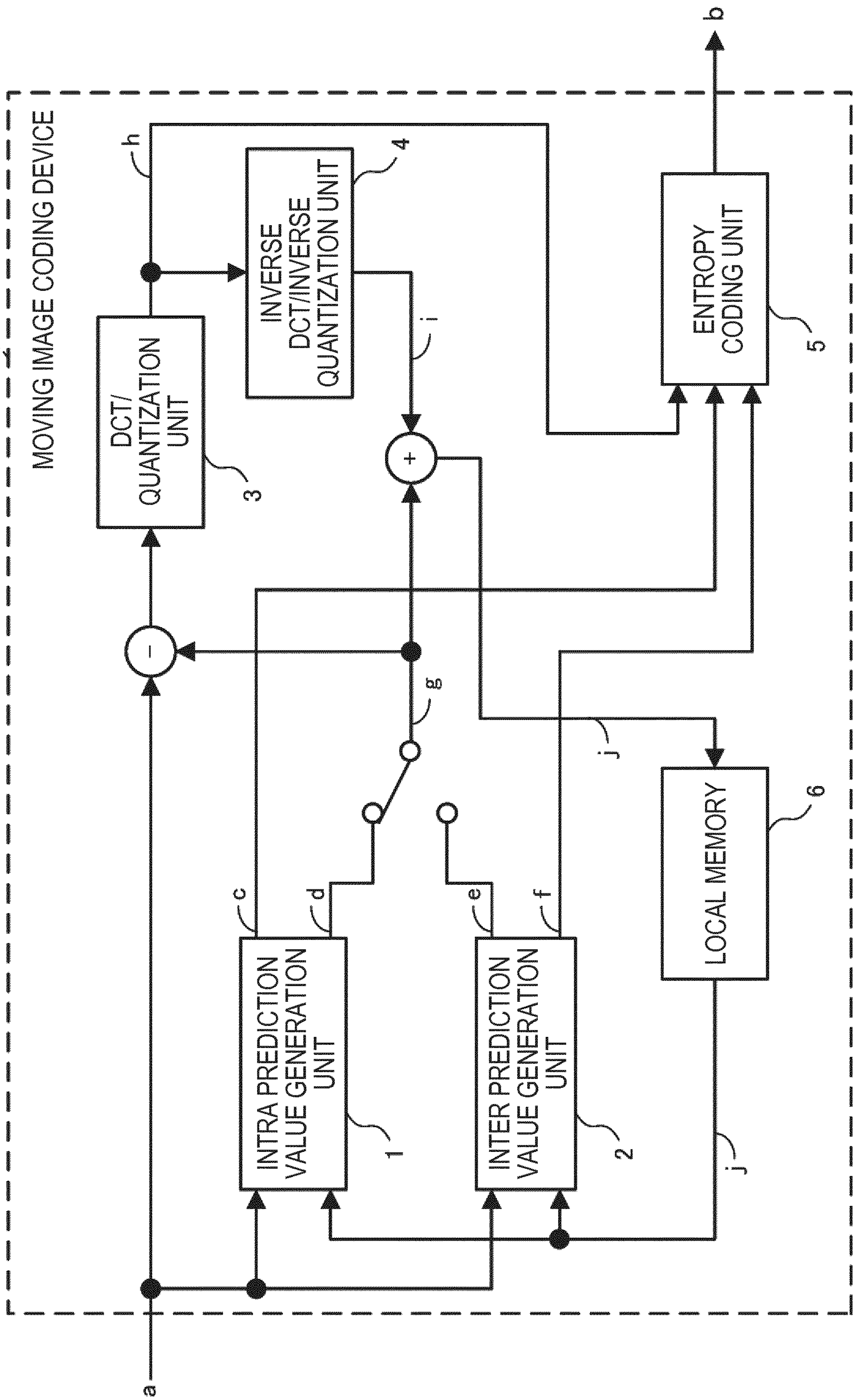

AA
MOVING IMAGE CODING DEVICE
DCT/
QUANTIZATION
UNIT
3
INVERSE
DCT/INVERSE
QUANTIZATION UNIT
4
ENTROPY
CODING UNIT
5
INTRA PREDICTION
VALUE GENERATION
UNIT
1
INTER PREDICTION
VALUE GENERATION
UNIT
2
LOCAL MEMORY
6
a
b
c
d
e
f
g
h
i
j
j
+
−

FIG. 2

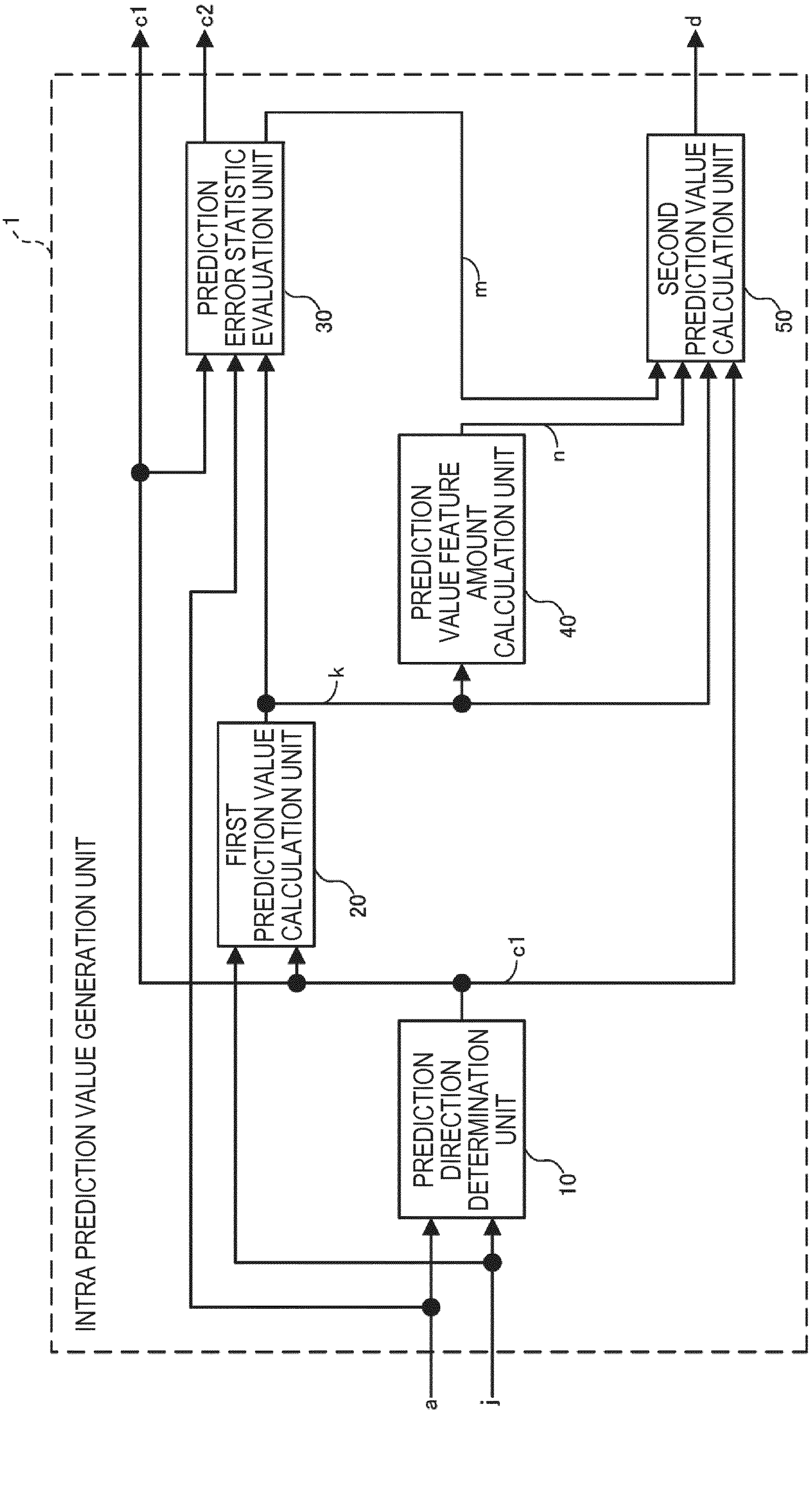

INTRA PREDICTION VALUE GENERATION UNIT
1
PREDICTION DIRECTION DETERMINATION UNIT
10
FIRST PREDICTION VALUE CALCULATION UNIT
20
PREDICTION ERROR STATISTIC EVALUATION UNIT
30
PREDICTION VALUE FEATURE AMOUNT CALCULATION UNIT
40
SECOND PREDICTION VALUE CALCULATION UNIT
50
a
j
c1
c2
d
k
m
n

FIG. 3

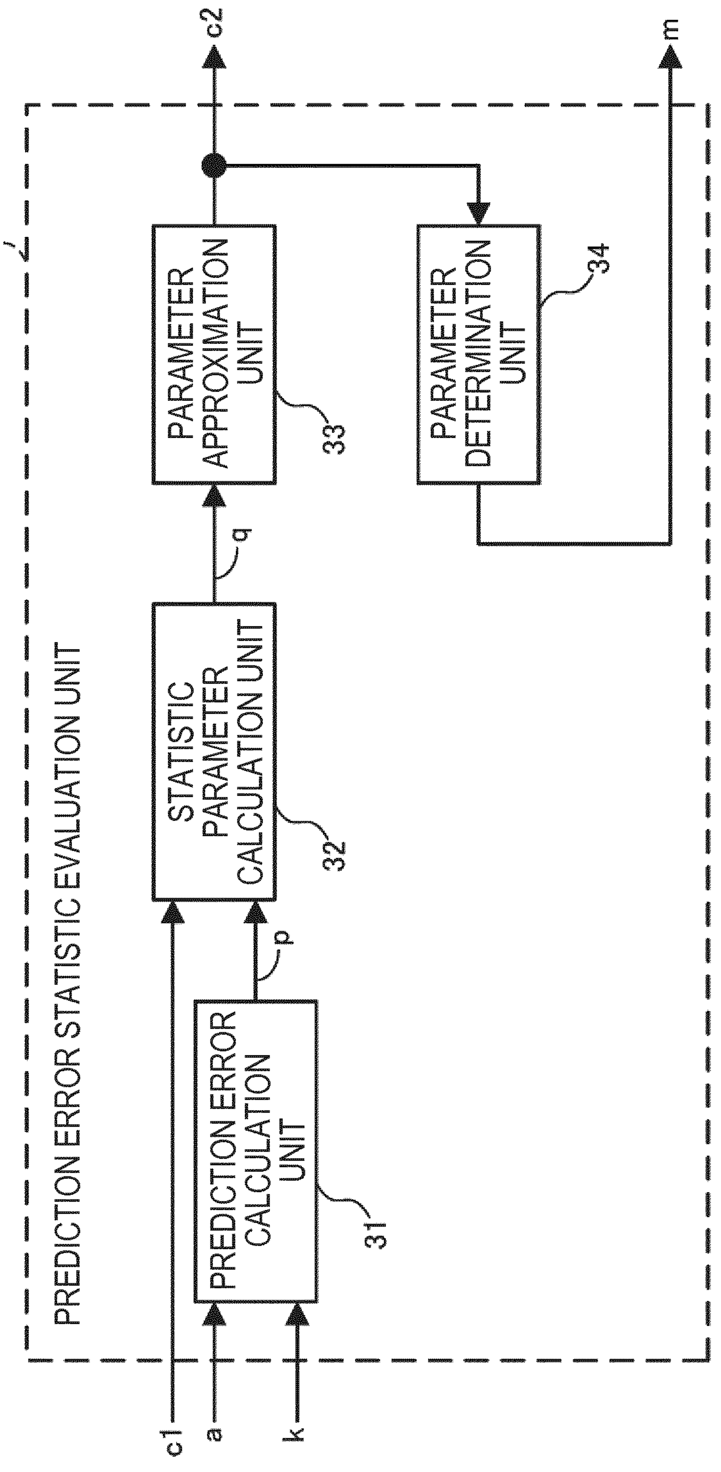

PREDICTION ERROR STATISTIC EVALUATION UNIT
30
PREDICTION ERROR CALCULATION UNIT
31
STATISTIC PARAMETER CALCULATION UNIT
32
PARAMETER APPROXIMATION UNIT
33
PARAMETER DETERMINATION UNIT
34
c1
a
k
p
q
c2
m

FIG. 4

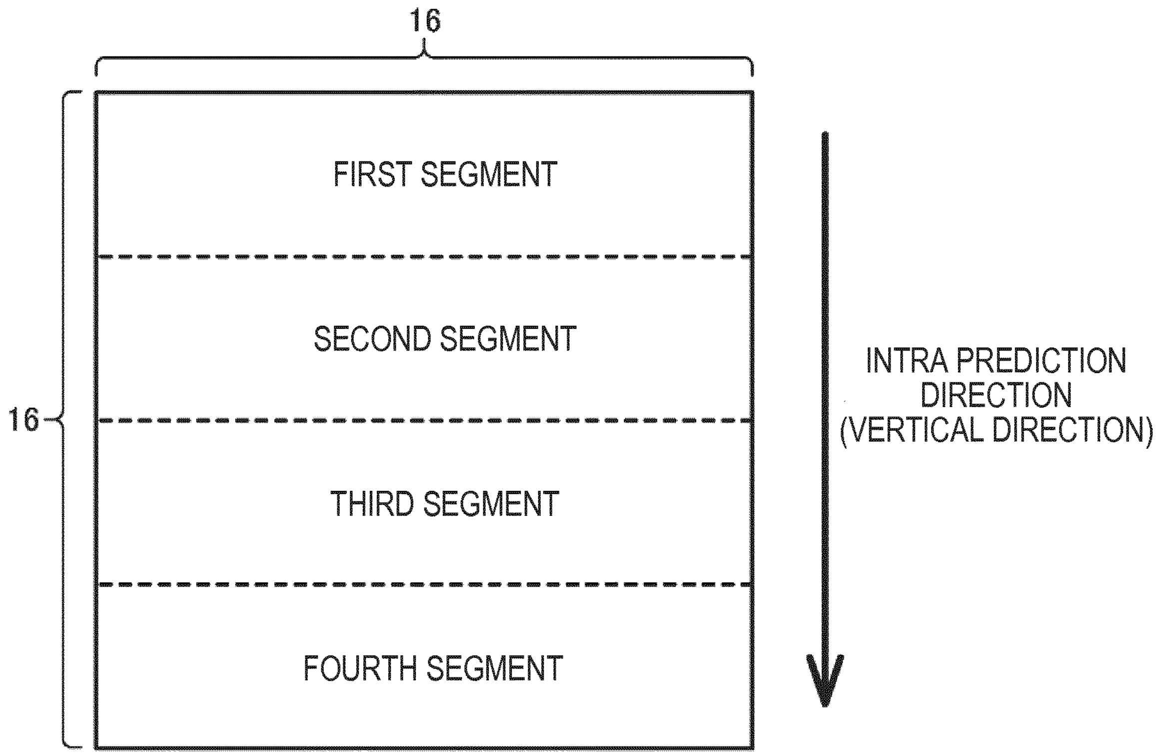

16
16
FIRST SEGMENT
SECOND SEGMENT
THIRD SEGMENT
FOURTH SEGMENT
INTRA PREDICTION
DIRECTION
(VERTICAL DIRECTION)

FIG. 5

PIXEL VALUES OF INPUT IMAGE

99	100	99	102	98	94	102	100	98	98	99	99	97	99	100	100
97	100	98	95	97	102	95	97	99	98	100	99	102	95	95	98
104	99	100	100	98	102	99	95	99	100	102	100	98	99	96	99
94	98	100	97	105	95	98	98	98	98	99	98	98	97	97	99

INTRA PREDICTION VALUES

98	99	99	98	99	98	99	98	99	94	97	98	98	102	99	97
98	99	99	98	99	98	99	98	99	94	97	98	98	102	99	97
98	99	99	98	99	98	99	98	99	94	97	98	98	102	99	97
98	99	99	98	99	98	99	98	99	94	97	98	98	102	99	97

INTRA PREDICTION RESIDUALS

ROOT MEAN SQUARE OF INTRA PREDICTION RESIDUALS : 8.125

1	1	0	4	−1	−4	3	2	−1	4	2	1	−1	−3	1	3
−1	1	−1	−3	−2	4	−4	−1	0	4	3	1	4	−7	−4	1
6	0	1	2	−1	4	0	−3	0	6	5	2	0	−3	−3	2
−4	−1	1	−1	6	−3	−1	0	−1	4	2	0	0	−5	−2	2

FIG. 6

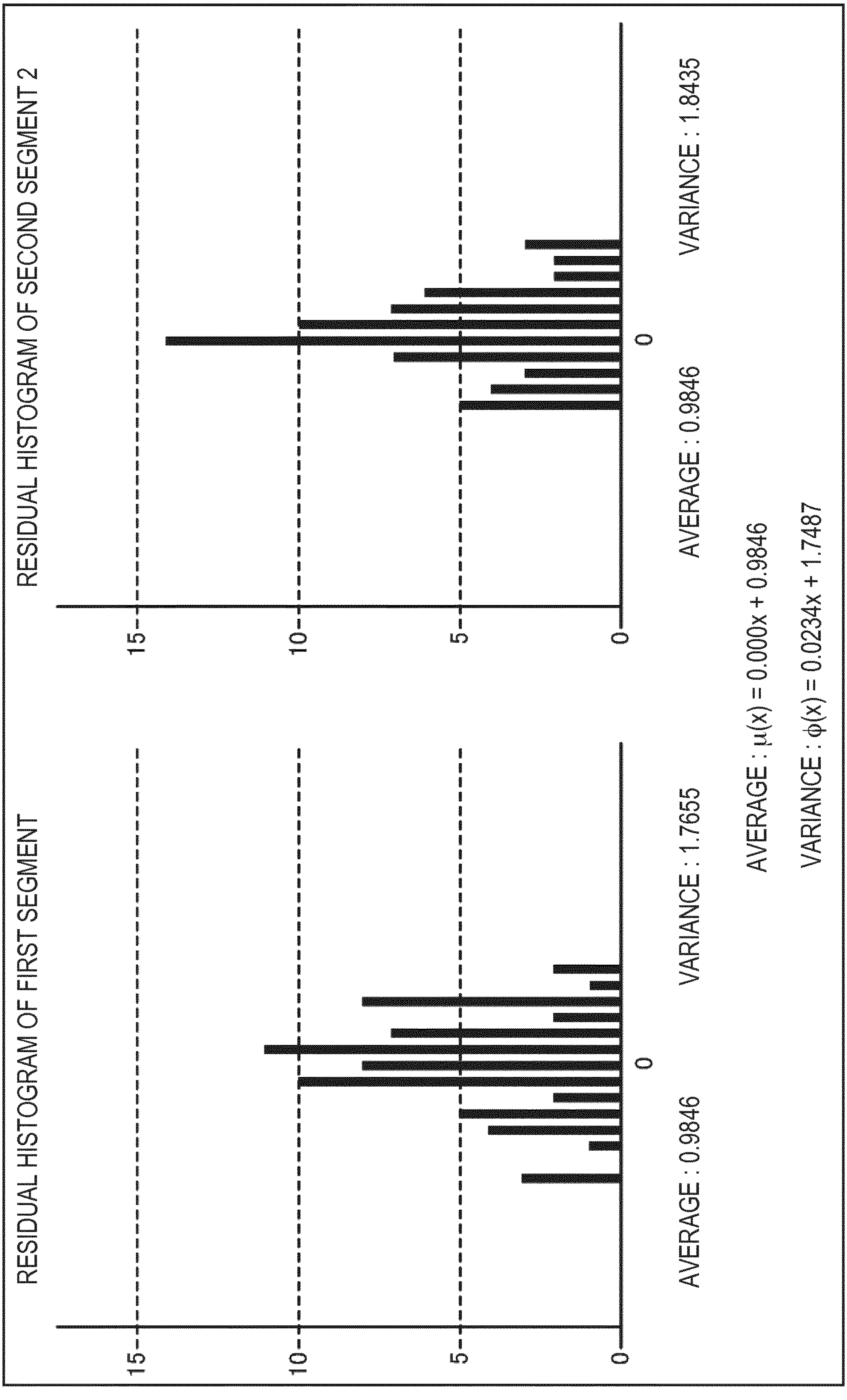
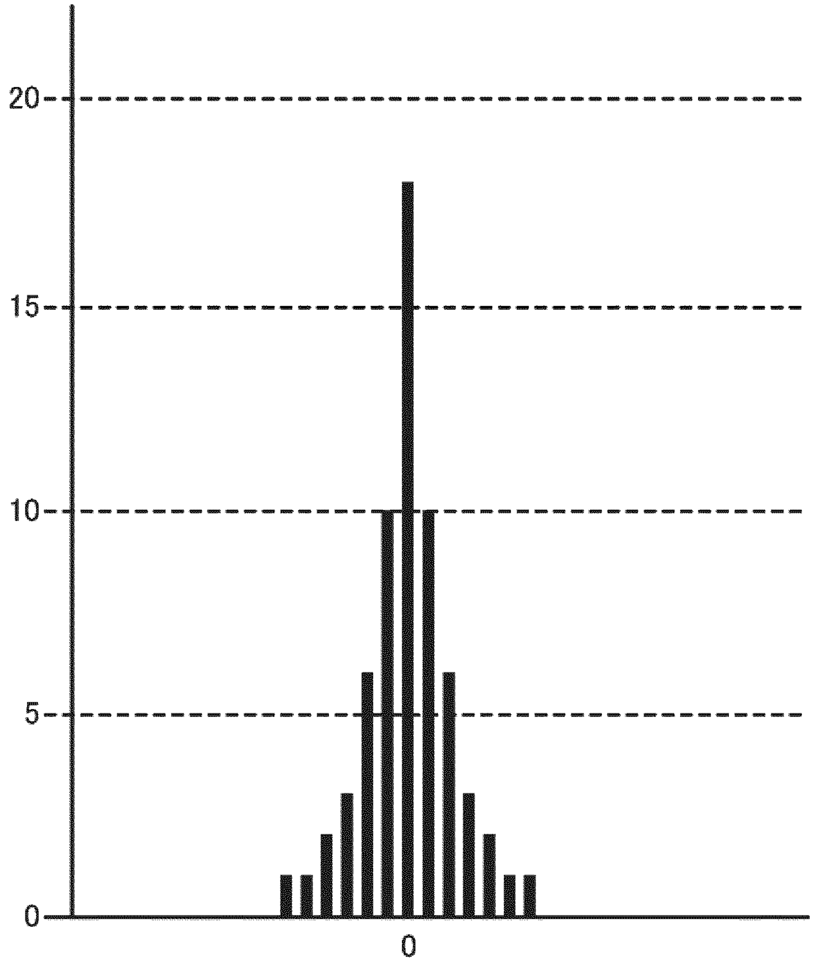

RESIDUAL HISTOGRAM OF FIRST SEGMENT
15
10
5
0
0
AVERAGE : 0.9846
VARIANCE : 1.7655
RESIDUAL HISTOGRAM OF SECOND SEGMENT 2
15
10
5
0
0
AVERAGE : 0.9846
VARIANCE : 1.8435
AVERAGE : μ(x) = 0.000x + 0.9846
VARIANCE : φ(x) = 0.0234x + 1.7487

FIG. 7

ESTIMATED VALUES AND LAPLACE DISTRIBUTION OF AVERAGE AND VARIANCE OBTAINED FROM APPROXIMATION FUNCTION



AVERAGE : 0.9846 VARIANCE : 1.7721

F I G. 8

FEATURE AMOUNTS OF RESPECTIVE PIXELS IN SEGMENT 1

98.76	98.48	98.76	98.6	98.68	98.44	98.32	97.96	97.76	97.44	97.44	97.8	98.56	99	98.96	98.76
98.44	98.6	98.32	98.56	98.56	98.48	98.32	98	97.44	97.24	97.2	97.76	98.68	99.12	98.8	98.52
98.44	98.2	98.6	98.56	98.56	98.48	98.36	97.92	97.48	96.92	97.2	97.88	98.6	99.16	98.96	98.48
97.96	98.6	98.64	98.56	98.56	98.48	98.36	97.92	97.48	96.92	97.2	97.88	98.6	99.12	98.88	98.36

DISTRIBUTION CLASSES ARE ALLOCATED TO RESPECTIVE PIXELS IN ACCORDANCE WITH SEQUENCING OF FEATURE AMOUNTS

−1	1	−1	0	−1	1	1	2	3	3	3	2	0	−3	−2	−2
1	0	1	1	1	1	2	1	4	4	6	3	−1	−2	−1	1
1	1	0	1	1	1	2	2	3	7	5	2	0	−4	−3	1
2	0	0	0	0	1	2	2	3	5	4	2	0	−5	−1	1

PREDICTION VALUES ARE UPDATED IN ACCORDANCE WITH ALLOCATION (ADD ALLOCATED VALUES TO PREDICTION VALUES)

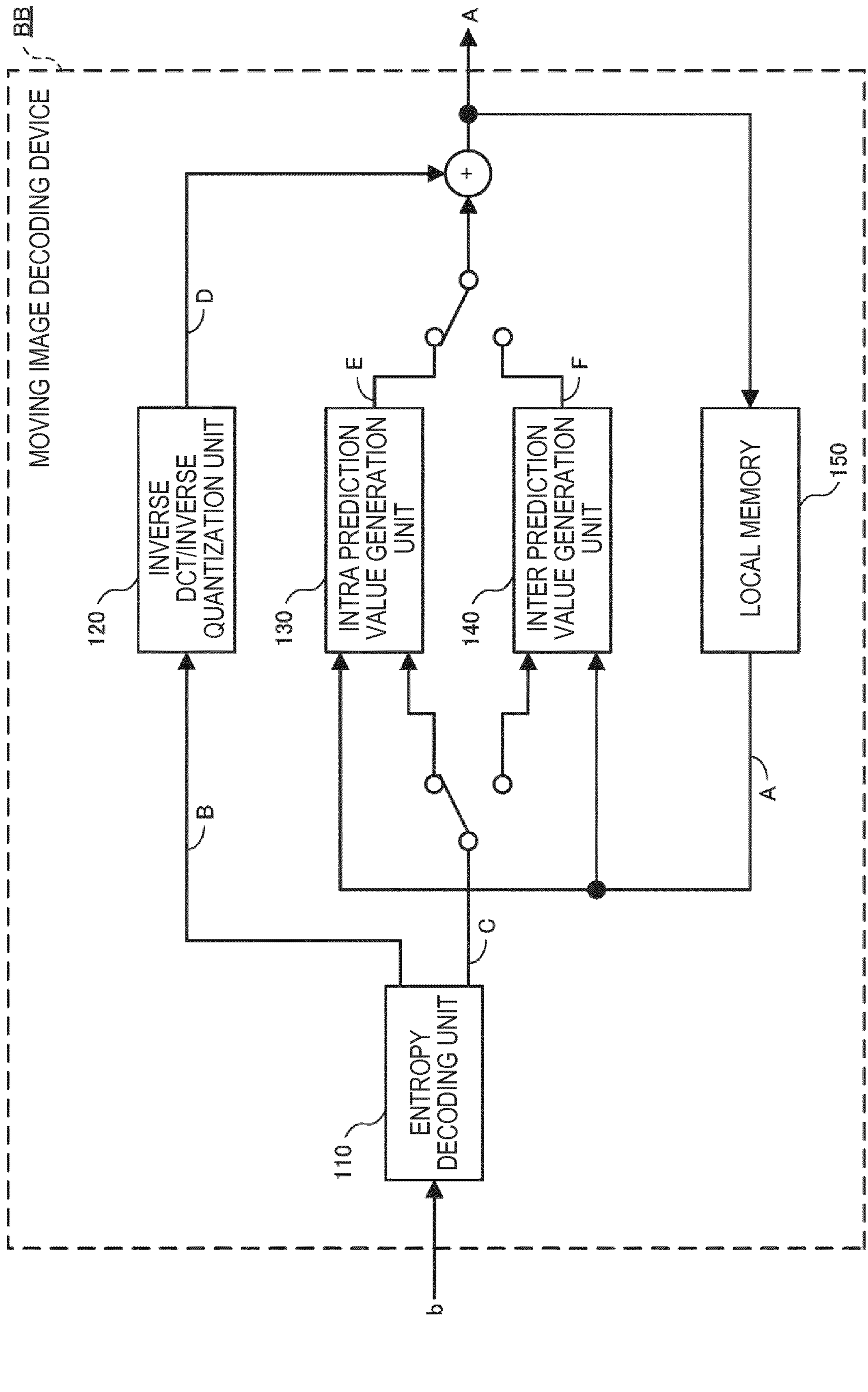
97	100	98	98	98	99	100	100	102	97	100	100	98	99	97	95
99	99	100	99	100	99	101	99	103	98	103	101	97	100	98	98
99	100	99	99	100	99	101	100	102	101	102	100	98	98	96	98
100	99	99	98	99	99	101	100	102	99	101	100	98	97	98	98

INTRA PREDICTION RESIDUALS BASED ON UPDATED PREDICTION VALUES

ROOT MEAN SQUARE OF INTRA PREDICTION RESIDUALS : 7.625

2	0	1	4	0	−5	2	0	−4	1	−1	−1	−1	0	3	5
−2	1	−2	−4	−3	3	−6	−2	−4	0	−3	−2	5	−5	−3	0
5	−1	1	1	−2	3	−2	−5	−3	−1	0	0	0	1	0	1
−6	−1	1	−1	6	−4	−3	−2	−4	−1	−2	−2	0	0	−1	1

FIG. 9


BB
MOVING IMAGE DECODING DEVICE
ENTROPY DECODING UNIT
110
INVERSE DCT/INVERSE QUANTIZATION UNIT
120
INTRA PREDICTION VALUE GENERATION UNIT
130
INTER PREDICTION VALUE GENERATION UNIT
140
LOCAL MEMORY
150
A
B
C
D
E
F
b
+

F I G. 10

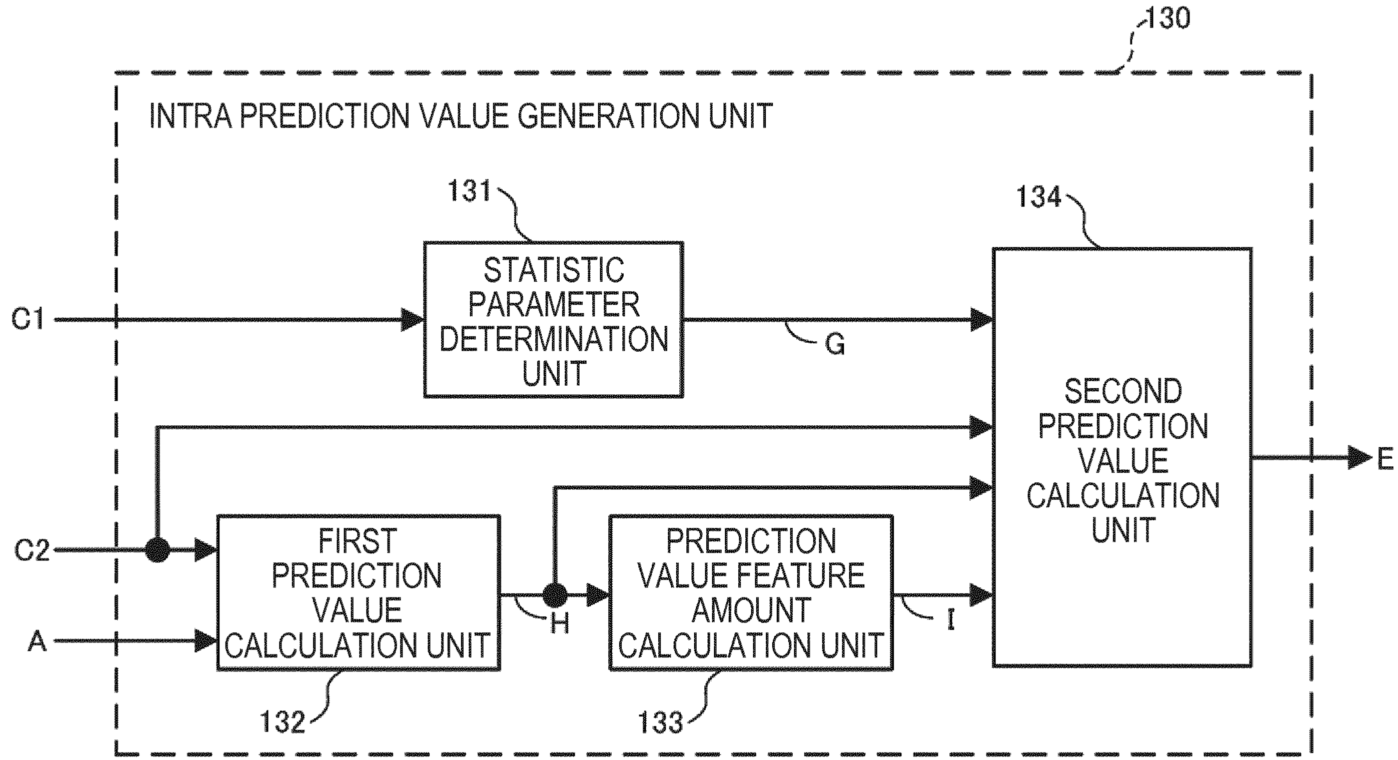
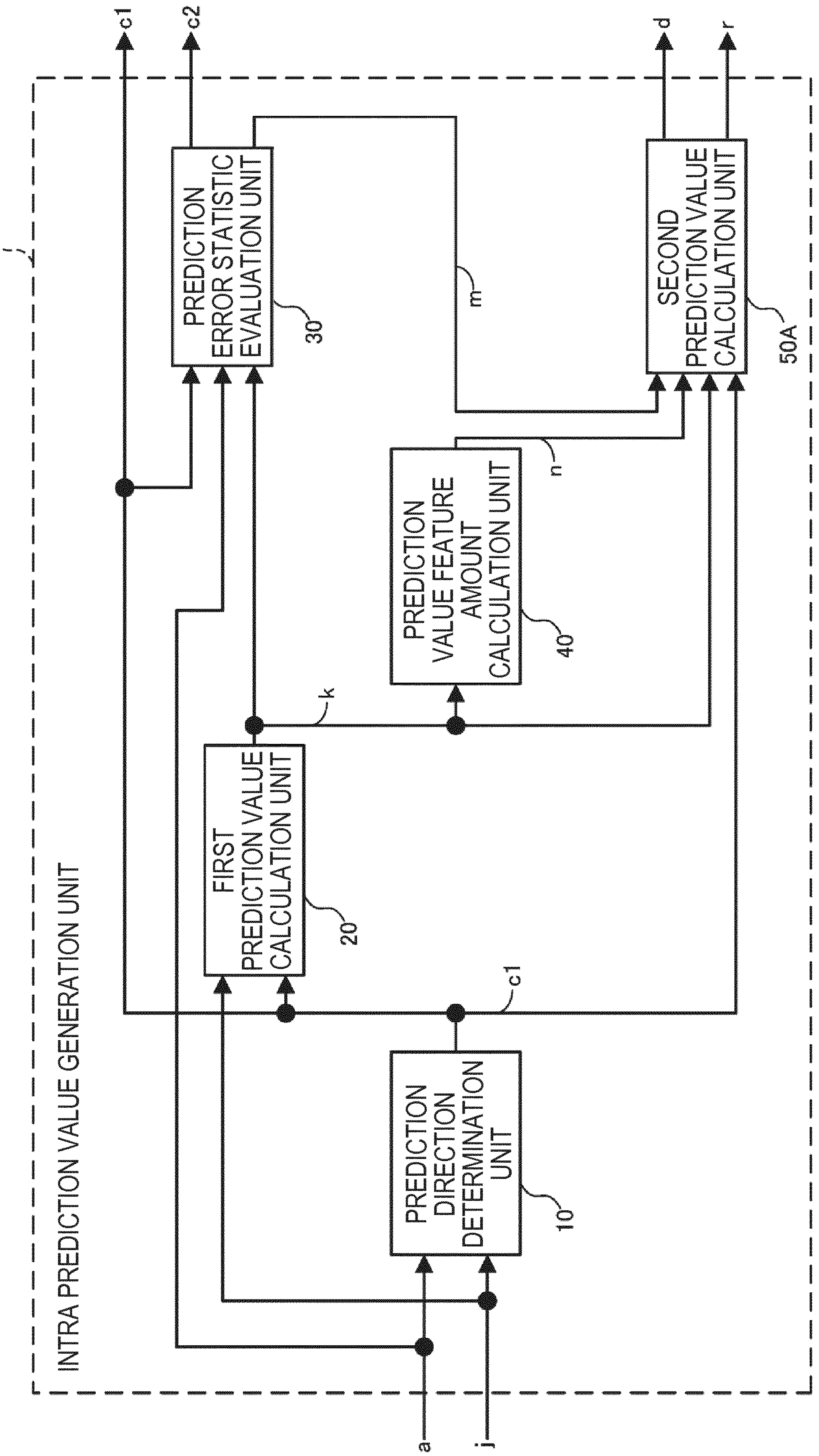

130
INTRA PREDICTION VALUE GENERATION UNIT
131
STATISTIC PARAMETER DETERMINATION UNIT
134
SECOND PREDICTION VALUE CALCULATION UNIT
C1
G
E
C2
A
FIRST PREDICTION VALUE CALCULATION UNIT
H
PREDICTION VALUE FEATURE AMOUNT CALCULATION UNIT
I
132
133

FIG. 11


INTRA PREDICTION VALUE GENERATION UNIT
1A
PREDICTION DIRECTION DETERMINATION UNIT
10
FIRST PREDICTION VALUE CALCULATION UNIT
20
PREDICTION ERROR STATISTIC EVALUATION UNIT
30
PREDICTION VALUE FEATURE AMOUNT CALCULATION UNIT
40
SECOND PREDICTION VALUE CALCULATION UNIT
50A
a
j
c1
c2
k
m
n
d
r

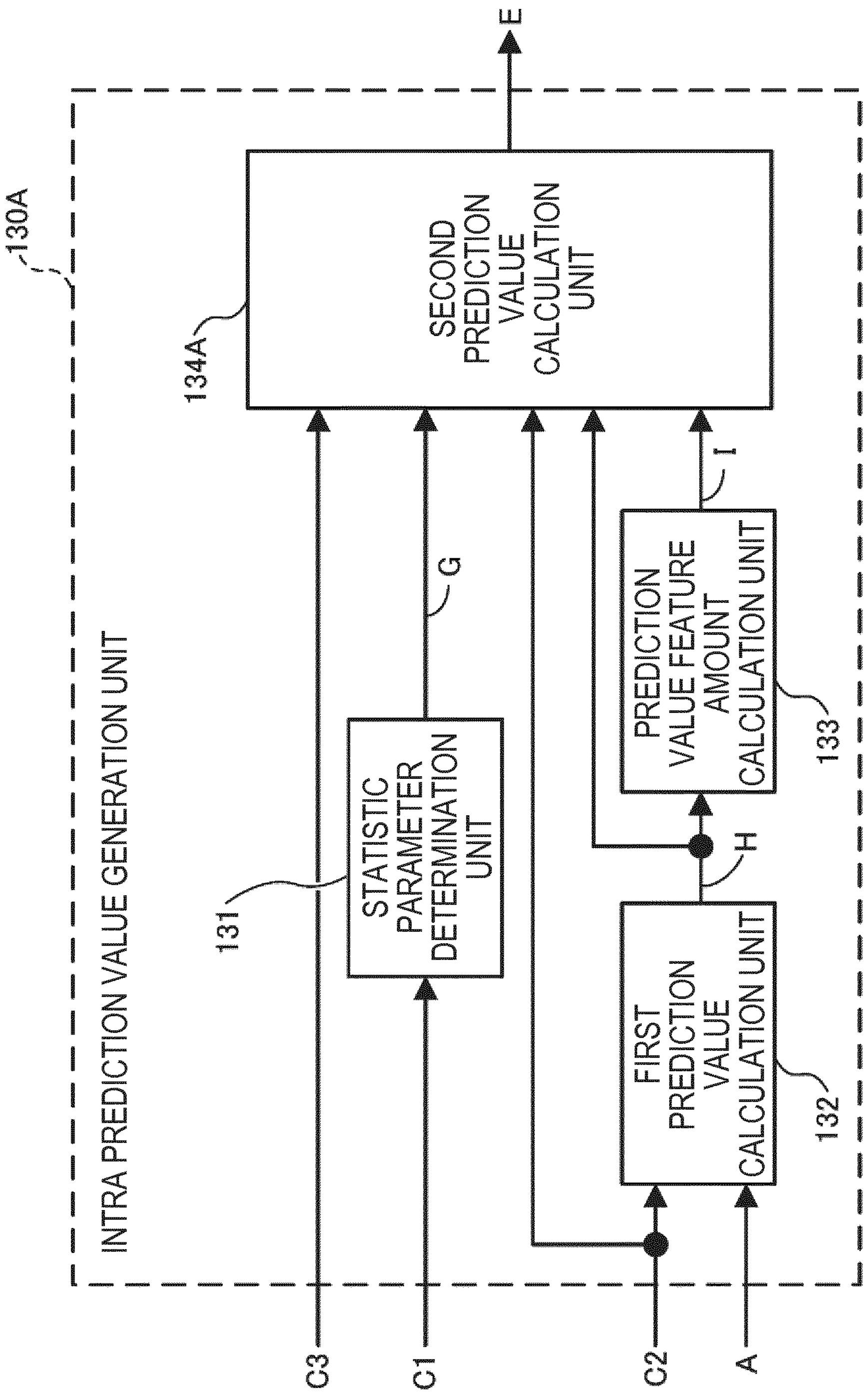

INTRA PREDICTION VALUE GENERATION UNIT
130A
134A
SECOND PREDICTION VALUE CALCULATION UNIT
131
STATISTIC PARAMETER DETERMINATION UNIT
132
FIRST PREDICTION VALUE CALCULATION UNIT
133
PREDICTION VALUE FEATURE AMOUNT CALCULATION UNIT
C3
C1
C2
A
G
H
I
E

FIG. 12

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/075639

A. CLASSIFICATION OF SUBJECT MATTER
H04N19/11(2014.01)i, *H04N19/136*(2014.01)i, *H04N19/157*(2014.01)i, *H04N19/176*(2014.01)i, *H04N19/593*(2014.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H04N19/00-19/98

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho	1922-1996	Jitsuyo Shinan Toroku Koho	1996-2014
Kokai Jitsuyo Shinan Koho	1971-2014	Toroku Jitsuyo Shinan Koho	1994-2014

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2009/051091 A1 (Nippon Telegraph and Telephone Corp.), 23 April 2009 (23.04.2009), paragraphs [0043] to [0085]; fig. 1 to 6 & CA 2701893 A & TW 200931986 A & KR 10-2010-0065183 A & EP 2200324 A1 & US 2010/0208803 A1 & CN 101822062 A & RU 2010113343 A	1-24
A	JP 2008-245088 A (KDDI R&D Laboratories, Inc.), 09 October 2008 (09.10.2008), paragraphs [0016] to [0053]; fig. 1 to 16 & US 2008/0240238 A1	1-24

☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
05 November, 2014 (05.11.14)	18 November, 2014 (18.11.14)

Name and mailing address of the ISA/	Authorized officer
Japanese Patent Office	
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2014/075639

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 2005/107267 A1 (Hitachi, Ltd.), 10 November 2005 (10.11.2005), page 14, line 13 to page 20, line 25; fig. 8 to 10 & US 2005/0243920 A1	1-24
A	JP 2008-271422 A (NTT Docomo Inc.), 06 November 2008 (06.11.2008), paragraphs [0040] to [0052]; fig. 5 to 7 (Family: none)	1-24
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